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EXFILE: A PROGRAM FOR COMPILING IRRADIATION DATA ON UN AND UC FUEL PINS

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ABSTRACT

A FORTRAN-IV computer program for handling fuel pin data is described. Its main features include standardized output, easy access for data manipulation, and tabulation of important material property data. An additional feature allows simplified preparation of input decks for a fuel swelling computer code (CYGRO-2). Data from over 300 high-temperature nitride-and carbide-based fuel pin irradiations have been listed.

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E-7420

SUMMARY

A large amount of fuel pin irradiation data exists in the literature, covering a wide range in test conditions and materials. This data has been used quite often in the NASA-Lewis work on developing a model to predict fuel pin behavior in nuclear space power systems.

To facilitate the handling of this data, a computer program has been written. Its main purpose is to standardize the data and provide easy access for calculations and tabulations. It also has additional features which allow simplified preparation of input decks for an existing fuel swelling code (CYGRO-2).

Data from over 300 irradiations have been listed. All are high-temperature carbide - or nitride-based fuel pins with various clad materials.

INTRODUCTION

In the last decade, much attention has been given to the study of ceramic nuclear fuels operating at high temperatures. The effort at NASA-Lewis has been aimed primarily towards space nuclear power systems. A major problem area, common to all such systems, is the eventual swelling of the metal clad fuel pins. Accurate knowledge of such swelling is required for the design of reliable, compact, efficient reactors.

Although much in-core testing of various fuel/clad combinations has been done, many aspects of the swelling problem remain uncertain. This is due primarily to the complexity of the many interrelated processes occurring during irradiation. In addition, the wide variety in test conditions, materials and geometry makes it difficult to isolate the effects of any single parameter. The time and expense of in-pile testing

shows the desirability of analytical models to predict fuel swelling. Such models still need experimental data, however, both in their development and in their verification.

In the course of the work on UN and UC swelling models at NASA-Lewis, much irradiation data was accumulated from diverse sources. To aid in the efficient use of this data, a computer program (EXFILE) was written to store the data. The program also contains additional features for retrieval and use of the data. The purpose of this program is threefold: (1) to provide a single source for all the fuel irradiation data on UN and UC, (2) to standardize the data with respect to units and format, and (3) to allow rapid access to the data for calculations and comparisons.

This report describes the features of the program, and lists a summary of the data for the 300-odd experiments that have been filed. A listing of the program is presented in Appendix A, and the experimental data is given in Appendix B.

PROGRAM DESCRIPTION

The program consists of a main routine for data filing, plus additional subroutines for special purposes. It is written in FORTRAN-IV and is used on an IBM-7094. Tape storage is used for the experimental data. A complete listing of the program is given in Appendix A.

Main Filing Program

The three main functions of the filing program are: (1) reading the input; (2) manipulating the data; and (3) writing the output. These are described in more detail below.

Input.- Card input is in three blocks: (1) references; (2) symbols; and (3) experiment data packages. Input for each experiment consists of the parameters listed in Table I. In addition, any individual reactor cycle data on conditions or results can be included. Corrections to an experiment data package can be made by simply correcting the card input and resubmitting that package. Other experiment packages do not need to be re-run. New experiments are added by putting their data packages at the end of a regular data set.

Data manipulation.- After a set of experimental data is read in, several calculations are made, namely volumetric

heating rate, average centerline fuel temperature, average clad temperature and burnup. These parameters, as well as the input, are stored on a main experiment file tape. In addition, certain of the more important parameters are stored on another tape. This is used for the abbreviated summary sheet output described below.

Output.- The standard output package for each experiment consists of a page for the total and/or average parameters, plus one or two pages for individual reactor cycle data if included. All of this data is expressed in SI units. If desired, output can be called on for only those experiments being corrected or added.

Besides the standard output, there is a summary listing of all experiments. This gives one line of the most important parameters for each experiment. The parameters on the summary sheet are given in more conventional units, and are listed in Table II.

A complete listing of the summary sheet data and a sample of the experiment output are given in Appendix B.

Additional Subroutines

Properties subroutine.- This routine (PROPS) contains properties for various fuel and clad materials, as well as some gases which may be present inside the pin. It is used in certain calculations for the main program, such as heat generation and fuel temperature drop. It is also used to tabulate properties for the card punching subroutine described in the next section.

Table III lists the materials and properties included. The properties are given as functions of temperature, porosity or other parameter where applicable. Most are in the form of polynomial equations fitted to experimental data. Sources for the data are given in references (1 to 46).

Card preparation subroutine.- Input for the CYGRO-2 fuel swelling code (ref. 47) requires many calculations and tabulations. A typical data set has about 100 cards. In order to speed up this process and decrease chances for a mistake, a subroutine (CYCARD) is available to prepare this input. Specification of a few CYGRO variables is all that is required.

CYCARD calculates all parameters required for CYGRO input. In addition, it contains fission-gas release models. It tabulates material properties using the PROPS subroutine, and punches the cards. An additional feature provides for overriding any of the experiment information.

User-written subroutine.- This routine is used for the experimental data. If desired, the subroutine is called after each set of data is read into the core. All pertinent variables are contained in common blocks. User-written FORTRAN can be used to store and manipulate the data from either the experiment data packages or the summary tape. An example of how this could be used would be :store all experimental burnup and clad strain output and either tabulate this data or call a library plotting subroutine.

COMPILATION OF DATA

Experimental data are given in Appendix B. Complete experiment data was not included due to space limitations, but a sample is included. It will be noted that much information is missing. The compilation relied almost exclusively on published information, some of which was 10 years old. It is felt, however, that all recent work is represented. Appendix B contains the complete summary sheet listing, symbols list, reference list, and an example of one of the experimental data sheets.

CONCLUDING REMARKS

A computer program (EXFILE) has been described for handling data on fuel pin experiments. It was written to enable efficient storage, retrieval and manipulation of the data. Results from over 300 UN and UC fuel pin tests, available in the literature, were filed with the program.

Additional features of the program include:

(1) CYGRO-2 input deck preparation

(2) Materials properties subroutine

(3) User-written routines for data handling

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TABLE I.-EXPERIMENT INPUT PARAMETERS

Parameters	Explanation/Units
Experiment number	
Identification	24-character code; firm, capsule and pin identification
References	
Test dates	Start and end dates
Number of cycles	Number of reactor cycles inputted
Notes	Letter-codes for standardized comments on summary sheet
Radii	Clad inner and outer, fuel inner and outer, plug inner and outer; cm
Lengths	Fuel and outer clad; cm
Void ratio	Ratio of pin void volume to macroscopic fuel volume
Material codes	6-character standardized codes for fuel, clad, plug and internal gas
Material type	12-character code for additional description of fuel and clad
Densities	Fuel and clad, percent of theoretical
Fuel grain size	Microns
Fuel enrichment	Percent of U-235
Stoichiometry	Weight percent of nonuranium material
Pressures	Initial cold internal and external pressures; N/cm^2
Time	Irradiation time; hr
Number of thermal cycles	
Burnup gradients	Ratio of max/min total burnup in axial and radial directions
Burnup rate	Percent of original uranium; hr^{-1}
Gamma heating rate	W/g
Fluxes	Neutron, fast and thermal; $cm^{-2}sec^{-1}$
Temperatures	Fuel inner, fuel outer, clad. Maximum, minimum and average (with respect to time) for each. ^oK
Strains	Maximum, minimum and average (with respect to geometry) changes in clad o.d., fuel i.d. and o.d., fuel and clad length, fuel volume. Percent
Fission gas release	Percent released, referenced to total produced
Comments	Any data in addition to information listed above.

TABLE II.-SUMMARY SHEET OUTPUT PARAMETERS

Parameter	Units
Experiment number	
Identification	
Fuel material	
Fuel density	percent of theoretical
Clad material	
Clad thickness	mils
Radial fuel/clad gap	mils
Time	hr
Average fuel temperature	^{o}K
Average clad temperature	^{o}K
Clad OD	in
Fuel ID	in
Burnup	atom percent (of original U)
Fuel volume change	percent
Clad OD change	percent
Gas release	percent
Notes	

TABLE III. - PARAMETERS INCLUDED IN PROPERTIES SUBROUTINE

Fuel Materials	Fuel Properties
UN - High and low oxygen impurity	Theoretical density
UC	Fission-gas generation rate
90 m/o UC - 10 m/o ZrC + 4 w/o W	Solid fission product swelling factor
50 m/o UC - 50 m/o ZrC + 4 w/o W	Uranium density
UC + 4 w/o W	Surface tension

Clad Materials	Fuel and Clad Properties
T-111 (Ta-8W-2Hf)	Thermal expansion - function of temp.
T-222 (Ta-10W-2.5Hf-0.01C)	Elastic modulus - function of temp., porosity
ASTAR-811C (Ta-8W-1Re-0.7Hf-0.025C)	Poisson's ratio
Ta-10W	Thermal conductivity - function of temp., porosity
Nb-1Zr	Creep rate - function of temp., stress
PWC-11 (Nb-1Zr-0.1C)	
D-43 (Nb-9W-1Zr)	
TZM (Mo-0.5Ti-0.08Zr-0.03C)	
TZC (Mo-1.2Ti-0.25Zr-0.15C)	
W-25Re	
W-25Re-30Mo	
W-Sintered	
W-Powder metallurgy	
W-Chemically vapor-deposited	

Gas Materials	Gas Properties
He	Thermal conductivity - function of temp.
Ne	Van der Waals constants
Ar	
Kr	
Xe	
Li	
Li-2	
N_2	

APPENDIX A. - FORTRAN LISTING


```
$IBFTC XFMAIN  DEBUG,DECK
C
C         PROGRAM READS, RECORDS AND USES INFORMATION ON FUEL IRRADIATION TESTS.
C
C               PRESENTLY DIMENSIONED FOR 230 REFS, 230 SYMBOLS ---60 CYCLES AND
C                  8 REFERENCES PER EXPERIMENT. TWO 2400' TAPES NOW BEING USED.
C                  TAPE WILL HOLD ABOUT 200 MULTI-CYCLE EXP. OR ABOUT 700 SINGLE-
C                  CYCLE EXPERIMENTS.
C
C               TAPE EXF001 USED FOR EXPERIMENT SUMMARY INFORMATION.
C
C               MAY CALL FOR UP TO 20 SETS OF CYGRO CARDS PER RUN.
C
C               SUB1 IS A USER-WRITTEN SUBROUTINE CALLED WHILE EACH EXPERIMENT
C                  IS IN THE CORE. CAN BE USED FOR CALCULATIONS,TABULATIONS,ETC.
C                  SUB2 IS AN ENTRY USED WHEN SUMMARY TAPE IS TO BE SEARCHED.
C
C
C               SYMBOLS NOT DEFINED IN OUTPUT------
C               A,B    =LARGE ARRAYS WITH EXPERIMENT INFORMATION.
C               CHECK =ARRAY(2) USED TO DETERMINE IF A OR B ARRAY IS USED.
C               SUMM  =ARRAY USED TO SAVE DATA FOR EXP SUMMARY
C               REFNOS=ARRAY OF REF NOS. FOR A PARTICULAR EXP.
C               NREFS =NO. OF REFS FOR A PARTIC. EXP.
C               REFNUM=NO. OF A REFERENCE (1 TO 230)
C               REF    =ARRAY (230*12) WITH REFERENCE TEXTS.
C               DEFN   =ARRAY (230*12) WITH SYMBOL TEXTS.
C               TPNUM =NO. OF CURRENT TAPE, 1 OR 2
C               NTOT   =TOTAL NO. OF EXPERIMENTS ON CURRENT TAPE.
C               NSUMM =NO. OF SUMMARY SHEETS DESIRED.
C               NCARD =ARRAY(20) OF EXP. NOS. FOR WHICH CYGRO CARDS ARE DESIRED.
C               NFILE =THE NO. OF THE NEXT EXP. ON THE TAPE BEING READ.
C               DUM    =ARRAY TO HOLD DATA ON 1ST EXP. CARD UNTIL READY.
C
      INTEGER TPNUM,SUBOPT
      REAL ID,NREFS,NC,NCOMM,NOTES,NF,NC,LIMOUT
      DIMENSION A(3000),B(800),DUM(16),SUMM(30),ISUMM( 6),REFNUM(230),
     1          SYM(230),REF(230,12),DEFN(230,12),CHECK(2),NCARD(20)
      COMMON/COM1/EXNUM,RCYC,RB,RMC,RMF,RA,RP,RPI,FL,CL,VF,NREFS,FCODE,        13
     1             CCODE,PCODE,GCODE,FD,CD,GS,ENR,STO,P,PWATER,ID(4),          27
     1             DATE(2),REFNOS(8),FTYPE(2),CTYPE(2),TTOT,TCTOT,BDOTAV,      44
     1             GRDRAV,GRDZAV,GAMAV,FFXAV,TFXAV,RAV,TFOAV(3),TFIAV(3),      56
     1             TCAV(3),DRMFAV(3),DRAAV(3),DFLAV(3),DVAV(3),DRBAV(3),       74
     1             DCLAV(3),COMM(20,13),NCOMM,CODE(10),CDATE(10),             358
     1             FNUM(10),CALC(10,9),RMRKS(30,11),BU,NOTES(8),              797
     1             QFUEL,CTAVE,FTAVE,                                         800
     1             CYCT(60),THCYC(60),GRADR(60),GRADZ(60),BDOT(60),          1100
     1             GAMMA(60),FFLUX(60),TFLUX(60),R(60),TFO(60,3),            1520
     1             TFI(60,3),TC(60,3),DRMF(60,3),DRA(60,3),DFL(60,3),        2420
     1             DV(60,3),DRB(60,3),DCL(60,3)                              2960
      COMMON/COM2/CY,SFF,RAP,RBP,FP(4),FQ(4),UDENS,FRHO,FTENS,CF1,CF2,NF
     1,            FALPHA(4),FE(4),FNU(4),FK(4),FC(4),FG(4),SFC,CTENS
     1,            CP(4),CQ(4),CNU(4),CRHO,CC1,CC2,NC,CALPHA(4),CE(4)
     1,            CK(4),CC(4),CG(4),CGAP,RVDW,AVDW,BVDW,PRHO
      COMMON/COM4/NTOT,NNN,SUMM,KSUB2
      COMMON/THC/C7,C8,C9,C10,C11
      EQUIVALENCE (A(1),EXNUM,REFNUM(1),SYM(1),B(1),CHECK(1)),
     1             (A(231),REF(1,1),DEFN(1,1))   ,
     1             (A(2991),TOTREF,TOTSYM)
      NAMELIST/OPTS/REFCHG,SYMCHG,EXPNEW,EXPCOR,EXPADD,EXPOUT,TPNUM,NTOT
```

```
  1,              NSUMM,NCARD,SUBOPT,LIMOUT
   DATA YES,NO,BLANK,BLNK2/6HYES    ,6HNO    ,6H      ,2H  /
   F(C1,C2,C3,C4,C5,T) = C1+C2*T+C3*T**2+C4*T**3+C5*T**4
   EXPCUT = NO
   LIMCUT = NO
   REFCHG = NO
   SYMCHG = NO
   EXPNEW = NO
   EXPCOR = NO
   EXPADD = NO
   EXPCHG = NO
   TPCHG =  NO
   NCARD(1)=0
   NDUM=1
   SUBOPT=0
 1 FORMAT(F3.0,3X,12A6)
 2 FORMAT(F4.0,2X,4A6,2(2X,A6),2X,8F3.0,F8.0)
 3 FORMAT(10E8.0)
 4 FORMAT(4A6,5E6.0,2(1X,2A6))
 5 FORMAT(I2,13A6)
 6 FORMAT(1H1,//  ,33X,18H**REFERENCE LIST**,///)
 7 FORMAT(I8,3H.  ,12A6)
 8 FORMAT(A6,2X,12A6)
 9 FORMAT(1H1,////,28X,31H** SYMBOLS AND ABBREVIATIONS **,////)
10 FORMAT(A6,2X,12A6)
11 FORMAT(3X,A6,5X,12A6)
12 FORMAT(A2,13A6)
13 FORMAT(1H1,55X,19HEXPERIMENT FILE NO.,I3)
14 FORMAT(56X,22(1H*))
15 FORMAT(22H0IDENTIFICATION CODE  ,4A6,4H // 11HTEST DATES ,A6,4H TO
  1 ,A6,4H // ,10HREFERENCES,8F5.0)
16 FORMAT(8H0FUEL...,A6,1H(,2A6,4H)    ,8HDENSITY=,F6.2,9H PERCENT,,
  2      12H ENRICHMENT=,F5.2,9H PERCENT,,12H GRAIN SIZE=F7.1,9H MICR
  3ONS,,9H STOICH.=F6.3,8H PERCENT)
17 FORMAT(8H0CLAD...,A6,1H(,2A6,4H)    ,8HDENSITY=,F6.2,8H PERCENT)
18 FORMAT(17H0PLUG MATERIAL...,A6)
19 FORMAT(16H0INTERNAL GAS...,A6,3H AT,F6.2,19H N/SQCM INIT.(COLD))
20 FORMAT(1H0,9X,16HINITIAL GEOMETRY,24X,31HTEST CONDITIONS (AVERAGE/
  2TOTAL) ,15X,24HTEST TEMPERATURES, DEG K)
21 FORMAT(1X,34(1H-),15X,31(1H-),15X,24(1H-))
22 FORMAT(26H CLAD OUTER RADIUS (CM) = ,F9.6,15X,22HTEST TIME (HRS)
  2    =,F9.0,15X,18HFUEL INNER (MAX) =,F6.0)
23 FORMAT(26H CLAD INNER RADIUS (CM) = ,F9.6,15X,22HNO. OF THERMAL CY
  2CLES=,F9.0,15X,18HFUEL INNER (MIN) =,F6.0)
24 FORMAT(26H FUEL OUTER RADIUS (CM) = ,F9.6,15X,22HBURNUP RATE(A/O/H
  4OUR)=,1PE9.2,15X,18HFUEL INNER (AVG) =,0PF6.0)
25 FORMAT(26H FUEL INNER RADIUS (CM) = ,F9.6,15X,22HGAMMA HEAT RATE (
  5W/G)=,E9.2,15X,18HFUEL OUTER (MAX) =,F6.0)
26 FORMAT(26H PLUG OUTER RADIUS (CM) = ,F9.6,15X,22HFAST FLUX (/SQCM-
  6S)  =,E9.2,15X,18HFUEL OUTER (MIN) =,F6.0)
27 FORMAT(26H PLUG INNER RADIUS (CM) = ,F9.6,15X,22HTHERMAL FLUX(/SQC
  7M-S)=,E9.2,15X,18HFUEL OUTER (AVG) =,F6.0)
28 FORMAT(26H FUEL LENGTH (CM)        = ,F9.6,15X,22HMAX/MIN B.U.(RADI
  8AL) =,F9.5,15X,18HCLAD OUTER (MAX) =,F6.0)
29 FORMAT(26H CLAD LENGTH (CM)        = ,F9.6,15X,22HMAX/MIN B.U. (AXI
  9AL) =,F9.5,15X,18HCLAD OUTER (MIN) =,F6.0)
30 FORMAT(26H VOID VOLUME/FUEL VOLUME= ,1PE9.2,15X,22HEXT.OP.PRESS.(N
  1/SQCM)=,0PF9.5,15X,18HCLAD OUTER (AVG) =,F6.0)
31 FORMAT(44HLTEST RESULTS (ALL VALUES IN PERCENT).......)
32 FORMAT(1H0,12X,8HDRMF/RMF,11X,6HDRA/RA,12X,6HDFL/FL,13X,4HDV/V,13X
```

```
  2,6HDRB/RB,12X,6HDCL/CL, 8X,11HGAS RELEASE)
33 FORMAT(4X,8HMAX---   ,7(F9.4, 9X))
34 FORMAT(4X,8HMIN---   ,7(F9.4, 9X))
35 FORMAT(4X,8HAVG---   ,6(F9.4, 9X),F9.4)
36 FORMAT(11HONOTES.....)
37 FORMAT(10X,13A6)
38 FORMAT(1H0,50X,47H(SEE INDIVIDUAL CYCLE DATA ON FOLLOWING SHEETS))
39 FORMAT(1H1,      45X,25HINDIVIDUAL CYCLE DATA ON ,4A6       )
40 FORMAT(132H0CYC    TIME    THER     BOOT     GAMMA     FLUX,PER SQCM-S
  2  GRADR  GRADZ   INNER FUEL TEMP,K    OUTER FUEL TEMP,K    CLAD TE
  3MPERATURE,K)
41 FORMAT(132H NO.     HR      CYC    A/O/HR     W/G       FAST    THERMAL
  2                   MAX     MIN     AVG     MAX     MIN     AVG     MAX
  3MIN    AVG )
42 FORMAT(I3,F9.0,F6.0,1PE10.2,0PF7.3,2(2X,1PE8.2),2(0PF7.3),9F7.0)
43 FORMAT(1H0)
44 FORMAT(132H0CYC  GAS     DV/V,FUEL,PERCENT      DRB/RB, PERCENT
  2DRMF/RMF, PERCENT      DRA/RA, PERCENT      DFL/FL, PERCENT   DCL/CL
  3, PERCENT  )
45 FORMAT(132H NO.  RLS     MAX     MIN     AVG     MAX     MIN     AVG
  2MAX     MIN     AVG     MAX     MIN     AVG     MAX    MIN    AVG    MAX
  3MIN   AVG  )
46 FORMAT(1X,I2,13F7.2,1X,6F6.2)
47 FORMAT(1H1,///45X,35HRECORD OF CALCULATIONS FOR EXP. NO.,I3,///,
  13X,4HCODE,4X,4HDATE,4X,4HFILE,4X,2HDV,5X,3HDDC,3X,4HDDFO,3X,4HDDFI
  1,3X,3HDLF,3X,3HDLC,2X,7HREMARKS/2X,130(1H*))
48 FORMAT(A2,13A6)
49 FORMAT(/3(2X,A6),4F7.2,2F6.2,2X,11A6/66X,11A6/66X,11A6)
50 FORMAT(1H1,//,55X,23HEXPERIMENT FILE SUMMARY/55X,23(1H-),///)
51 FORMAT(4H EXP,7X,14HIDENTIFICATION,8X,99HFUEL MATL   CLAD MAT'L  R
  1GAP  TIME  TEMP,DEG K  BURNUP  DIAMETER,IN.  DV/V   DD/D  GAS REL
  1 NOTES      /
  1       4H NO.,                      29X,99H(DENSITY)    (THK,MILS)  M
  1ILS  HRS   FUEL  CLAD    O/O   CLAD    HOLE   O/O    O/O    O/O
  1(BELOW)      )
52 FORMAT(1X,I3,2X,4A6,2X,A6,1H(,I3,3H)  ,A6,1H(,I3,1H),I4,I7,2I6,2X,
  1F5.2,3X,2(F5.3,2X),3(F5.2,2X),8A1)
53 FORMAT(1H1,////,10X,10(1H*),16H NAMELIST INPUT ,10(1H*),///)
54 FORMAT(1H0,50X,35H(NO INDIVIDUAL CYCLE DATA INCLUDED))
55 FORMAT(1H0,50X,37H(NO CALCULATION INFORMATION INCLUDED))
56 FORMAT(1HJ)
57 FORMAT(50X,22HBURNUP (ATOM PERCENT)=,F9.3)
58 FORMAT(9E8.0,8A1)
59 FORMAT(1HL,10HNOTES.....//,
  1     10X,120HA=POSSIBLE SIGNIFICANT CAN PRESSURE     F=EVIDENCE OF V
  1APOR TRANSPORT     K=HYPERSTOICHIOMETRIC        P=FUEL PIN VENTED
  1/,  10X,120HB=NITROGEN OVERPRESSURE ON FUEL          G=THERMOCOUPLE
  1INSIDE FUEL        L=HYPOSTOICHIOMETRIC         Q=MODELING REF. CASE
  1/,  10X,120HC=IMPORTANT TEST DATA MISSING            H=CHEMICAL REAC
  1TION FOUND         M=LITHIUM INSIDE PIN         R=FMODEL TEST CASE
  1/,  10X,120HD=TEMPERATURE EXCURSION OCCURRED         I=FUEL/CLAD GAP
  1 UNKNOWN           N=ODD CLAD MATERIAL          S=STILL ON TEST
  1/,  10X,120HE=LINER BETWEEN FUEL AND CLAD            J=CLAD IMMERSED
  1 IN NAK            O=CLAD FAILURE               T=CALCULATION MADE
  1,//5X,44HA ZERO MAY ACTUALLY SIGNIFY AN UNKNOWN VALUE)
60 FORMAT(1H1/1H2,50X,23HCURRENT TAPE IS NOW NO.,I2/51X,25(1H*))
61 FORMAT(50X,22HFISS. HEAT RATE(W/CC)=,F9.1)
62 FORMAT(F4.0,2X,3A6,9F6.0)
63 FORMAT(6X,11A6)
C
```

```
C            P R E L I M I N A R I E S
C
      WRITE(6,53)
      READ(5,OPTS)
      WRITE(6,OPTS)
      L=3
      M=4
      IF(TPNUM.EQ.2) L=4
      IF(TPNUM.EQ.2) M=3
      NNN=6
      IF(EXPOUT.EQ.YES) NNN=5
      IF(EXPNEW.EQ.YES) NNN=1
      IF(EXPCOR.EQ.YES) NNN=2
      IF(EXPADD.EQ.YES) NNN=3
      IF(EXPCOR.EQ.YES.AND.EXPADD.EQ.YES) NNN=4
      IF(NNN.LE.4) EXPCHG=YES
      IF(REFCHG.EQ.YES.OR.SYMCHG.EQ.YES.OR.EXPCHG.EQ.YES) TPCHG=YES
      IF((REFCHG.EQ.YES.OR.SYMCHG.EQ.YES).AND.EXPOUT.EQ.NO) NNN=5
      DEBUG NNN,L,M
C
C          R E F E R E N C E S
C
      IF(NNN.EQ.5.AND.LIMOUT.EQ.YES) GO TO 117
      IF(REFCHG.EQ.NO) GO TO 102
      DO 100 I=1,230
      READ(5,1) REFNUM(I),(REF(I,J),J=1,12)
      IF(REFNUM(I).EQ.0.) GO TO 101
  100 TOTREF = REFNUM(I)
  101 WRITE(M) A
      READ(L)
      GO TO 103
  102 IF(EXPOUT.EQ.NO) GO TO 107
      READ(L) A
      IF(TPCHG.EQ.YES) WRITE(M) A
  103 I = 1
      II=0
  104 WRITE(6,6)
      II=II+50
  105 WRITE(6,7) I,(REF(I,J),J=1,12)
      I=I+1
      IF (REFNUM(I).LT..5) GO TO 107
      IF(II-I) 104,105,105
  107 CONTINUE
C
C           S Y M B O L S
C
      IF(SYMCHG.EQ.NO) GO TO 112
      DO 110 I=1,230
      READ(5,10) SYM(I),(DEFN(I,J),J=1,12)
      IF(SYM(I).EQ.BLANK) GO TO 111
  110 TOTSYM = I
  111 CONTINUE
      WRITE(M) A
      READ(L)
      GO TO 113
  112 IF(EXPOUT.EQ.NO) GO TO 117
      READ(L) A
      IF(TPCHG.EQ.YES) WRITE(M) A
  113 I=1
      II=0
```

```
  114 WRITE(6,9)
      II=II+50
  115 WRITE(6,11) SYM(I),(DEFN(I,J),J=1,12)
      I=I+1
      IF(SYM(I).EQ.BLANK) GO TO 117
      IF(II-I) 114,115,115
  117 CONTINUE
C
C          E X P E R I M E N T A L   D A T A
C
      NN=1
      ADD=NO
      NFILE=1
      EXNUM=1.
      GO TO (1290,1100,1100,1100,1650,2000),NNN
 1100 READ(5,2) DUM
      IDUM=DUM(1)
      IF(IDUM.EQ.0.AND.NFILE.LE.NTOT) GO TO 1650
      IF(IDUM.EQ.0.AND.NFILE.GT.NTOT) GO TO 1900
 1200 NN=IDUM-NFILE
      IF(IDUM.GT.NTOT.AND.NFILE.EQ.NTOT+1) GO TO 1290
      IF(NN) 1650,1300,1650
 1290 ADD = YES
      IF(NNN.EQ.1) GO TO 1400
 1300 EXNUM=DUM(1)
      DO 1310 I=1,4
 1310 ID(I)=DUM(I+1)
      DATE(1)=DUM(6)
      DATE(2)=DUM(7)
      NREFS= 0.
      DO 1320 I=1,8
      REFNOS(I)=DUM(I+7)
      IF(REFNOS(I).EQ.0.) GO TO 1330
      NREFS=I
 1320 CONTINUE
 1330 RCYC=DUM(16)
      GO TO 1500
 1400 READ(5,2) EXNUM,ID,DATE,REFNOS,RCYC
      NREFS=0.
      DO 1410 I=1,8
      IF(REFNOS(I).EQ.0.) GO TO 1420
 1410 NREFS=I
 1420 CONTINUE
      IF(EXNUM.EQ.0.) GO TO 1900
 1500 READ(5,58) RB,RMC,RMF,RA,RP,RPI,FL,CL,VF,NOTES
      READ(5,4) FCODE,CCODE,PCODE,GCODE,FD,CD,GS,ENR,STO,FTYPE(1),
     1          FTYPE(2),CTYPE(1),CTYPE(2)
      READ(5,3) P,PWATER
      READ(5,3) TTOT,TCTOT,GRDRAV,GRDZAV,BDOTAV,GAMAV,FFXAV,TFXAV
      READ(5,3) TFOAV,TFIAV,TCAV
      READ(5,3) DRMFAV,DRAAV,DFLAV
      READ(5,3) RAV,DVAV,DRBAV,DCLAV
      KK=IFIX(RCYC)
      IF(KK.EQ.0) GO TO 1520
      DO 1510 J=1,KK
      READ(5,3) CYCT(J),THCYC(J),GRADR(J),GRADZ(J),BDOT(J),GAMMA(J),
     1          FFLUX(J),TFLUX(J)
      READ(5,3) (TFO(J,K),K=1,3),(TFI(J,K),K=1,3),(TC(J,K),K=1,3)
      READ(5,3) (DRMF(J,K),K=1,3),(DRA(J,K),K=1,3),(DFL(J,K),K=1,3)
      READ(5,3) R(J),(DV(J,K),K=1,3),(DRB(J,K),K=1,3),(DCL(J,K),K=1,3)
```

```
 1510 CONTINUE
 1520 CONTINUE
      JJ=0
 1530 JJ=JJ+1
      READ(5,12) QQ,(COMM(JJ,K),K=1,13)
      NCOMM=JJ
      IF(QQ.EQ.BLNK2) GO TO 1530
      DO 1540 I=1,10
      READ(5,62)Q,CODE(I),CDATE(I),FNUM(I),(CALC(I,J),J=1,9)
      IF(Q.EQ.0.) GO TO 1550
      I1=1+3*(I-1)
      I2=I1+2
      DO 1540 J=I1,I2
 1540 READ(5,63) (RMRKS(J,K),K=1,11)
 1550 CONTINUE
C********* MISC. CALCULATIONS --  BU,QFUEL,CTAVE,FTAVE
 1560 BU = TTOT*BDOTAV
      FTAVI=TFIAV(3)
      FTAVO=TFOAV(3)
      CTAVE=TCAV(3)
      DO 1561 I=1,2
      IF(FTAVI.EQ.0.) FTAVI=TFIAV(I)
      IF(FTAVO.EQ.0.) FTAVO=TFOAV(I)
 1561 IF(CTAVE.EQ.0.) CTAVE=TCAV(I)
      IF(FTAVO.EQ.0.) FTAVO=CTAVE
      IF(CTAVE.EQ.0.) CTAVE=FTAVO
      CALL PROPS1
C                      THIS CALL GETS FUEL CONSTANTS REQ'D FOR CALCULATIONS
      CON1 = .01*GAMAV*FRHO*FD
      CON2 = 8.89E-19*BDOTAV*FD*UDENS
      QFUEL  = CON1 + CON2
      IF(FTAVO.GT.0..AND.FTAVI.GT.0.) GO TO 1564
      IF(FTAVO+FTAVI+CTAVE.LE.0.) GO TO 1565
      FTAVE=FTAVO
      SIGN=1.
      T1 = FTAVO
      IF(FTAVO.EQ.0.) SIGN=-1.
      IF(FTAVO.EQ.0.) FTAVE=FTAVI
      IF(FTAVO.EQ.0.) T1=FTAVI
      SCON =  QFUEL*RMF**2/4.
      IF(RA.LT.1.E-6) GO TO 1562
      RR=RA/RMF
      CON3 = .5*(1.-RR**2)
      CON4 = (RR**2)*ALOG(RR)
      SCON = QFUEL *RMF**2*(CON3+CON4)/2.
 1562 CONTINUE
      DO 1563 I=1,10
      T2 = 1.8*FTAVE - 460.
      COND = .2077*(F(C7,C8,C9,C10,C11,T2))
      DEL2 = SCON/2./COND
      FTAVE = T1 + SIGN*DEL2
 1563 CONTINUE
      IF(FTAVO.EQ.0.) CTAVE=FTAVE-   DEL2
      GO TO 1566
 1564 FTAVE=.5*(FTAVI+FTAVO)
      GO TO 1566
 1565 FTAVE=-0.
      CTAVE=-0.
 1566 CONTINUE
      IF(ACD.EQ.NO) GO TO 1600
```

```
      GO TO 1700
 1600 READ(L)
      READ(L)
      GO TO 1700
 1650 READ(L) CHECK
      IF(CHECK(2).EQ.0.) READ(L) B
      IF(CHECK(2).GT.0.) READ(L) A
      IF(LINOUT.EQ.YES) GO TO 1731
 1700 ITOT=EXNUM
      WRITE(6,13) ITOT
      WRITE(6,14)
      N1=NREFS
      WRITE(6,15) (ID(J),J=1,4),(DATE(J),J=1,2),(REFNOS(J),J=1,N1)
      WRITE(6,16) FCODE,(FTYPE(J),J=1,2),FD,ENR,GS,STC
      WRITE(6,17) CCODE,(CTYPE(J),J=1,2),CD
      WRITE(6,18) PCODE
      WRITE(6,19) GCODE,P
      WRITE(6,20)
      WRITE(6,21)
      WRITE(6,22) RB ,TTOT  ,TFIAV(1)
      WRITE(6,23) RMC,TCTOT ,TFIAV(2)
      WRITE(6,24) RMF,BDOTAV,TFIAV(3)
      WRITE(6,25) RA ,GAMAV ,TFOAV(1)
      WRITE(6,26) RP ,FFXAV ,TFOAV(2)
      WRITE(6,27) RPI,TFXAV ,TFOAV(3)
      WRITE(6,28) FL ,GRDRAV, TCAV(1)
      WRITE(6,29) CL ,GRDZAV, TCAV(2)
      WRITE(6,30) VF ,PWATER, TCAV(3)
      WRITE(6,57) BU
      WRITE(6,61) QFUEL
      WRITE(6,31)
      WRITE(6,32)
      WRITE(6,33) DRMFAV(1),DRAAV(1),DFLAV(1),DVAV(1),DRBAV(1),DCLAV(1)
      WRITE(6,34) DRMFAV(2),DRAAV(2),DFLAV(2),DVAV(2),DRBAV(2),DCLAV(2)
      WRITE(6,35) DRMFAV(3),DRAAV(3),DFLAV(3),DVAV(3),DRBAV(3),DCLAV(3),
     1            RAV
      WRITE(6,36)
      LLL=IFIX(NCOMM)
      DO 1710 J=1,LLL
 1710 WRITE(6,37) (COMM(J,K),K=1,13)
      IF(IFIX(RCYC).EQ.0) WRITE(6,54)
      IF(IFIX(RCYC).EQ.0) GO TO 1722
      WRITE(6,38)
      WRITE(6,39) (ID(J),J=1,4)
      WRITE(6,40)
      WRITE(6,41)
      LLL=IFIX(RCYC)
      DO 1720 J=1,LLL
 1720 WRITE(6,42) J,CYCT(J),THCYC(J),BDOT(J),GAMMA(J),FFLUX(J),TFLUX(J)
     1,           GRADR(J),GRADZ(J),(TFI(J,K),K=1,3),(TFO(J,K),K=1,3),
     1            (TC(J,K),K=1,3)
      IF(LLL.GT.24) WRITE(6,39) ID
      IF(LLL.LE.24) WRITE(6,56)
      WRITE(6,44)
      WRITE(6,45)
      DO 1721 J=1,LLL
 1721 WRITE(6,46) J,R(J),(DV(J,K),K=1,3),(DRB(J,K),K=1,3),
     1            (DRMF(J,K),K=1,3),(DRA(J,K),K=1,3),(DFL(J,K),K=1,3),
     1             (DCL(J,K),K=1,3)
 1722 CONTINUE
```

```
      IF(CODE(1).EQ.BLANK) WRITE(6,55)
      IF(CODE(1).EQ.BLANK) GO TO 1731
      WRITE(6,47) ITOT
      DO 1730 I=1,10
      IF(CODE(I).EQ.BLANK) GO TO 1731
      I1=1+3*(I-1)
      I2=I1+1
      I3=I1+2
 1730 WRITE(6,49) CODE(I),CDATE(I),FNUM(I),(CALC(I,J),J=2,7),
     1               (RMRKS(I1,J),J=1,11),(RMRKS(I2,J),J=1,11),
     1               (RMRKS(I3,J),J=1,11)
 1731 CONTINUE
      IF(NNN.EQ.5) GO TO 1850
C*************  STORE INFORMATION FOR SUMMARY
 1735 CONTINUE
      DO 1750 I=1,4
 1750 SUMM(I)=ID(I)
      SUMM(5)=FCODE
      SUMM(6)=FD + .5
      SUMM(7)=CCODE
      SUMM(8)=(RB-RMC)/2.54E-3  + .5
      SUMM(9)=(RMC-RMF)/2.54E-3  + .5
      SUMM(10)=TTOT
      SUMM(11)=FTAVE
      SUMM(12)=CTAVE
      SUMM(13)=BU
      SUMM(14)=2.*RB/2.54
      SUMM(15)=2.*RA/2.54
      SUMM(16)=DVAV(3)
      SUMM(17)=DRBAV(3)
      SUMM(18)=RAV
      SUMM(27)=EXNUM
      DO 1751 L=1,2
      IF(SUMM(16).EQ.0.) SUMM(16)= DVAV(L)
 1751 IF(SUMM(17).EQ.0.) SUMM(17)=DRBAV(L)
      DO 1752 I=1,8
 1752 SUMM(I+18) = NOTES(I)
      WRITE(7) SUMM
 1800 WRITE(M) CHECK
      IF(CHECK(2).EQ.0.) WRITE(M) B
      IF(CHECK(2).GT.0.) WRITE(M) A
 1850 CONTINUE
      IF(NCARD(NDUM).NE.ITOT) GO TO 1860
      CALL CYCARD
      NDUM=NDUM+1
 1860 CONTINUE
      IF(SUBOPT.EQ.1) CALL SUB1
      NFILE=NFILE+1
      IF(NTOT.EQ.NFILE-1.AND.NNN.EQ.5) GO TO 1900
      IF(TPCHG.EQ.NO) GO TO 1650
      IF(NFILE.EQ.NTOT+1.AND.IDUM.EQ.0.AND.NNN.EQ.2) GO TO 1900
      IF(ADD.EQ.YES.OR.NNN.EQ.1) GO TO 1400
      IF(IDUM.EQ.0) GO TO 1650
      IF(NN) 1200,1100,1200
 1900 IF(NNN.NE.1) REWIND L
      IF(TPCHG.EQ.YES) REWIND M
      IF(SUBOPT.EQ.1) SUBOPT=0
      IF(NNN.EQ.5) GO TO 2000
 1950 REWIND 7
 2000 IF(NSUMM.EQ.0) GO TO 2100
```

```
C
C **********  WRITE FILE SUMMARY
      IF(NNN.EQ.6) ITOT=NTOT
C
      IF(SUBOPT.EQ.2) NSUMM=1
      MM=(ITOT-1)/40 + 1
      DO 2040 MMM=1,NSUMM
      DO 2030 J=1,MM
      WRITE(6,50)
      WRITE(6,51)
      DO 2020 NN =1,40
      I=40*(J-1)+NN
      READ(7) SUMM
      IF(SUBOPT.EQ.2) CALL SUB2
      ISUMM(1) = SUMM(6)
      DO 2010 K=2,6
 2010 ISUMM(K)=SUMM(K+6)
      WRITE(6,52) I,(SUMM(K),K=1,5),ISUMM(1),SUMM(7),(ISUMM(K),K=2,6),
     1                 (SUMM(K),K=13,26)
      IF(NN.EQ.40.OR.I.EQ.ITOT) WRITE(6,59)
      IF(I.EQ.ITOT)  GO TO 2035
 2020 CONTINUE
 2030 CONTINUE
 2035 REWIND 7
 2040 CONTINUE
 2100 CONTINUE
 2200 JJJ=1
      IF(TPCHG.EQ.YES.AND.TPNUM.EQ.1) JJJ=2
      IF(TPCHG.EQ.NO) JJJ=TPNUM
      WRITE(6,60) JJJ
 3000 CONTINUE
      IF(NNN.NE.6) GOTO 3060
      IF(NCARD(NDUM).EQ.0) GO TO 3060
      READ(L)
      READ(L)
      NFILE=1
 3010 IF(NCARD(NDUM).LE.0) GO TO 3030
      NEXP=NCARD(NDUM)
      I = (NEXP-NFILE)*2
      DO 3020 J=1,I
      READ(L)
 3020 CONTINUE
      READ(L) CHECK
      IF(CHECK(2).EQ.0.) READ(L) B
      IF(CHECK(2).GT.0.) READ(L) A
      CALL CYCARD
      NDUM=NDUM+1
      NFILE=IFIX(EXNUM) + 1
      GO TO 3010
 3030 IF(NFILE.EQ.NTOT+1) GO TO 3050
      I=(NTOT-NFILE)*2 + 2
      DO 3040 J=1,I
 3040 READ(L)
 3050 REWIND L
 3060 CONTINUE
      IF(SUBOPT.EQ.0) GO TO 3080
      READ(L)
      READ(L)
      DO 3070 I=1,NTOT
      READ(L) CHECK
```

```
      IF(CHECK(2).EQ.0.) READ(L) B
      IF(CHECK(2).GT.0.) READ(L) A
      CALL SUB1
 3070 CONTINUE
      REWIND L
 3080 CONTINUE
      STOP
      END
$IBFTC PROP    DEBUG,DECK
      SUBROUTINE PROPS
C***************************************************************************
C      CALCULATES THE FOLLOWING MATERIAL PROPERTIES---                     *
C         CY     =GAS GENERATION CONSTANT FOR FUEL                         *
C         SFF,C  =SOLID SWELLING FACTOR FOR FUEL, CLAD                     *
C         RBP    =CONDUCTIVITY POROSITY FACTOR                             *
C         UDENS  =U DENSITY IN 100 PERCENT DENSE FUEL, PER CC              *
C         FRHO   =THEORETICAL DENSITY OF FUEL                              *
C         CRHO   =THEORETICAL DENSITY OF CLAD                              *
C         CGAP   =GAS CONDUCTIVITY, BTU/HR-IN-DEGF                         *
C         FTENS  =SURFACE TENSION OF FUEL, LB/IN                           *
C         ALPHA  =THERMAL EXP.(PER DEGF) = FCN. OF TEMPERATURE             *
C         E      =ELASTIC MODULUS(PSI) = FCN. OF TEMP AND/OR POROSITY      *
C         NU     =POISSON'S RATIO = FCN. OF TEMP AND/OR POROSITY           *
C         K      =THERMAL COND.(BTU/HR-IN-DEGF) = FCN. OF TEMPERATURE      *
C         C,G    =CYGRO CREEP CONSTANTS = FCNS. OF CF1,CF2,NF OR CC1,CC2,NC *
C         F,Q    =CYGRO PLASTICITY CONSTANTS -- PRESENTLY SET TO -25 AND 20. *
C         VAN DER WAALS GAS CONSTANTS                                      *
C                                                                          *
C      CF1,CF2,ETC. ARE IN UNITS OF N/CM2, DEG K, PER HR                   *
C      FOR THE CASE OF UNKNOWN UN O2 IMPURITY, ASSUMES HIGH IMPURITY CONTENT. *
C      PROPERTIES FROM IBF 6-7-72 MEMO WHERE AVAILABLE.                    *
C      UNKNOWN VALUES SET EQUAL TO 'ZERO', OR DUMMY CREEP CONSTANTS USED.  *
C      W, PMW, SINTW  ALL USE SINTW CREEP.                                 *
C      NOTE -- E AND NU FOR CLAD MAT'LS ARE NOT VALID BEYOND 3000F.        *
C                                                                          *
C      PROPS  CALLED FROM CYCARD TO GET PROPERTY VALUES                    *
C      PROPS1 CALLED FROM XFMAIN TO GET FUEL CONDUCTIVITY CONSTANTS.       *
C      PROPS2 USED TO GET A TABULATION OF PROPERTIES.                      *
C      PROPS3 USED TO CALCULATE CREEP STRENGTH AT SEVERAL TEMPERATURES.    *
C***************************************************************************
      REAL NF,NC
      COMMON/COM1/EXNUM,RCYC,RB,RMC,RMF,RA,RP,RPI,FL,CL,VF,NREFS,FCODE,        13
     1             CCODE,PCODE,GCODE,FD,CD,GS,ENR,STO,P,PWATER,ID(4),          27
     1             DATE(2),REFNOS(8),FTYPE(2),CTYPE(2),TTOT,TCTOT,BDOTAV,      44
     1             GRDRAV,GRDZAV,GAMAV,FFXAV,TFXAV,RAV,TFOAV(3),TFIAV(3),      56
     1             TCAV(3),DRMFAV(3),DRAAV(3),DFLAV(3),DVAV(3),DRBAV(3),       74
     1             DCLAV(3),COMM(20,13),NCOMM,CODE(10),CDATE(10),             358
     1             FNUM(10),CALC(10,9),RMRKS(30,11),BU,NOTES(8),              797
     1             QFUEL,CTAVE,FTAVE,                                         800
     1             CYCT(60),THCYC(60),GRADR(60),GRADZ(60),BDOT(60),          1100
     1             GAMMA(60),FFLUX(60),TFLUX(60),R(60),TFO(60,3),            1520
     1             TFI(60,3),TC(60,3),DRMF(60,3),DRA(60,3),DFL(60,3),        2420
     1             DV(60,3),DRB(60,3),DCL(60,3)                              2960
      COMMON/COM2/CY,SFF,RAP,RBP,FP(4),FQ(4),UDENS,FRHO,FTENS,CF1,CF2,NF
     1,            FALPHA(4),FE(4),FNU(4),FK(4),FC(4),FG(4),SFC,CTENS
     1,            CP(4),CQ(4),CNU(4),CRHO,CC1,CC2,NC,CALPHA(4),CE(4)
     1,            CK(4),CC(4),CG(4),CGAP,RVDW,AVDW,BVDW,PRHO
      COMMON/COM3/FT(4),CT(4),KODEF,KODEC,KODEG,KODEP
      COMMON/THC/C7,C8,C9,C10,C11
      DIMENSION CODEF(8),CODEC(23),CODEG(9),CODEP(7)
```

```
      DIMENSION TEMPS(5),STRESS(10)
      DATA BLNK6/6H      /
      DATA (CODEF(I),I=1,8)/6H    UN,6H UN-HI,6H UN-LO,6H    UC,6HU10ZRC
     1,6HL50ZRC,6H UC+4W,6H   UO2/,
     1     (CODEC(I),I=1,23)/6H T-111,6H T-222,6H  811C,6HTA-10W,6HNB-1Z
     1R,6HPWC-11,6H  D-43,6H   TZM,6H   TZC,6HW-25RE,6HW-26RE,6HW-REMO,
     16H    SS,6H     W,6H   PMW,6H SINTW,6H  CVDW,6H FCVDW,6H CCVDW,
     16H CCVDW,6HLFCVDW,6HHFCVDW,6HWALLOY/,
     1     (CODEG(I),I=1,9)/6HHELIUM,6H  NEON,6H ARGON,6HKRYPTN,6H XENON
     1,6H    LI,6H   LI2,6H     N,6H      /,
     1     (CODEP(I),I=1,7)/6H    MO,6H    SS,6H    TA,6H     W,6H    NB
     1,6H    RE,6H      /
C      F U N C T I O N S
C
C        C CREEP CONSTANT, GIVEN CF1(X1),CF2(X2),NF(X3) AND TEMP(T)  IN DEG K.
      F1(X1,X2,X3,T)= ALOG10(X1) + 2.83853*X3 - 0.434294* X2/T
C
C        YOUNG'S MODULUS FOR FUELS,GIVEN CONST.X1,X2,POR(X3),TEMP(T) IN DEG F.
      F2(X1,X2,X3,T)=    (X1-X2*X3)  *  (1.-6.16E-5*(T-77.)) * 1.E6
C
C        LINEAR FUNCTION ---
      F3(F,G,X)= F + G*X
C
C        GENERAL FUNCTION FOR 4TH-DEGREE POLYNOMIAL---
      F4(A,B,C,D,E,X) = A+B*X + C*X**2 + D*X**3 + E*X**4
C
C        FUNCTION FOR CONVERTING TO DEGREES K, GIVEN DEG F.
      DEGK(T)= 5.*(T+459.)/9.
C
C     FUNCTION FOR CREEP STRENGTH
      F5(A,B,C,D,E) = (E*(EXP(B/D))/A)**(1./C)
C
    1 FORMAT(4(4X,A6),4F10.0)
    2 FORMAT(10E8.0)
    3 FORMAT(1H1,///,15X,A6,/,15X,6(1H*),///)
    4 FORMAT(10E8.0)
    5 FORMAT(A6)
    6 FORMAT(1H1///35H STRESS TO PRODUCE A CREEP RATE OF ,1PE9.3,63H PER
     1 HOUR AT STATED TEMPERATURES(DEG.K).STRESS IN N/SQ.CM(PSI).///10H
     1 MATERIAL,5(8X,0PF5.0,9X),//)
    7 FORMAT(3X,A6,1X,5(4X,1PE8.2,1H(,1PE8.2,1H)))
      MMM=0
      GO TO 1000
      ENTRY PROPS1
      KODEF=0
      MMM=1
      GO TO 1000
      ENTRY PROPS2
      KODEF=0
      KODEC=0
      KODEP=0
      KODEG=0
      MMM=2
      READ(5,1) FCODE,CCODE,PCODE,GCODE,FC,GS,STO
      READ(5,2)FT,CT,CTAVE,FTAVE
      IF(FCODE.EQ.BLNK6) GO TO 1999
      GO TO 1000
      ENTRY PROPS3
      KODEF=0
      KODEC=0
```

```
      DIMENSION TEMPS(5),STRESS(10)
      DATA BLNK6/6H      /
      DATA (CODEF(I),I=1,8)/6H    UN,6H UN-HI,6H UN-LO,6H    UC,6HU10ZRC
     1,6HL50ZRC,6H UC+4W,6H   UO2/,
     1     (CODEC(I),I=1,23)/6H T-111,6H T-222,6H  811C,6HTA-10W,6HNB-1Z
     1R,6HPWC-11,6H  D-43,6H   TZM,6H   TZC,6HW-25RE,6HW-26RE,6HW-REMO,
     16H    SS,6H     W,6H   PMW,6H SINTW,6H  CVDW,6H FCVDW,6H CCVDW,
     16H CCVDW,6HLFCVDW,6HHFCVDW,6HWALLOY/,
     1     (CODEG(I),I=1,9)/6HHELIUM,6H  NEON,6H ARGON,6HKRYPTN,6H XENON
     1,6H    LI,6H   LI2,6H     N,6H      /,
     1     (CODEP(I),I=1,7)/6H    MO,6H    SS,6H    TA,6H     W,6H    NB
     1,6H    RE,6H      /
C     F U N C T I O N S
C
C        C CREEP CONSTANT, GIVEN CF1(X1),CF2(X2),NF(X3) AND TEMP(T)  IN DEG K.
      F1(X1,X2,X3,T)= ALOG10(X1) + 2.83853*X3 - 0.434294* X2/T
C
C        YOUNG'S MODULUS FOR FUELS,GIVEN CONST.X1,X2,POR(X3),TEMP(T) IN DEG F.
      F2(X1,X2,X3,T)=    (X1-X2*X3)  *  (1.-6.16E-5*(T-77.)) * 1.E6
C
C        LINEAR FUNCTION ---
      F3(F,G,X)= F + G*X
C
C        GENERAL FUNCTION FOR 4TH-DEGREE POLYNOMIAL---
      F4(A,B,C,D,E,X) = A+B*X + C*X**2 + D*X**3 + E*X**4
C
C        FUNCTION FOR CONVERTING TO DEGREES K, GIVEN DEG F.
      DEGK(T)= 5.*(T+459.)/9.
C
C     FUNCTION FOR CREEP STRENGTH
      F5(A,B,C,D,E) = (E*(EXP(B/D))/A)**(1./C)
C
    1 FORMAT(4(4X,A6),4F10.0)
    2 FORMAT(10E8.0)
    3 FORMAT(1H1,///,15X,A6,/,15X,6(1H*),///)
    4 FORMAT(10E8.0)
    5 FORMAT(A6)
    6 FORMAT(1H1///35H STRESS TO PRODUCE A CREEP RATE OF ,1PE9.3,63H PER
     1 HOUR AT STATED TEMPERATURES(DEG.K).STRESS IN N/SQ.CM(PSI).///10H
     1 MATERIAL,5(8X,0PF5.0,9X),//)
    7 FORMAT(3X,A6,1X,5(4X,1PE8.2,1H(,1PE8.2,1H)))
      MMM=0
      GO TO 1000
      ENTRY PROPS1
      KODEF=0
      MMM=1
      GO TO 1000
      ENTRY PROPS2
      KODEF=0
      KODEC=0
      KODEP=0
      KODEG=0
      MMM=2
      READ(5,1) FCODE,CCODE,PCODE,GCODE,FD,GS,STO
      READ(5,2)FT,CT,CTAVE,FTAVE
      IF(FCODE.EQ.BLNK6) GO TO 1999
      GO TO 1000
      ENTRY PROPS3
      KODEF=0
      KODEC=0
```

```
 8CC REAC(5,4) RATE,TEMPS
     DO E05 I=1,5
     IF(TEMPS(I).EQ.C.) GO TC 806
 8C5 NTEMP=I
 8C6 CONTINUE
     WRITE(6,6) RATE,(TEMPS(I),I=1,NTEMP)
     MMM=31
 81C REAC(5,5) FCODE
     IF(FCODE.NE.BLNK6) GO TC 1006
 82C REAC(5,5) CCODE
     MMM=32
     IF(CCODE.EQ.BLNK6) GO TC 5000
     GO 10 9999
 83C CONTINUE
     C20=CF1
     C21=CF2
     C22=NF
     CON1=FCODE
     GO 10 850
 84C C20=CC1
     C21=CC2
     C22=NC
     CON1=CCODE
 85C CONTINUE
     DO E6C I=1,NTEMP
     J=2*(I-1)+1
     STRESS(J)= F5(C20,C21,C22,TEMPS(I),RATE)
 860 STRESS(J+1) = STRESS(J)/.6895
     NNN=2*NTEMP
     WRITE(6,7) CON1,(STRESS(I),I=1,NNN)
     IF(MMM.EQ.31) GC TO 810
     GO 10 820
1CCC ZERC=C.
C********* INITIALIZE FUEL PARAMETERS
     CY= .125
     SFF= 1.
     RAP=1.
     RBP=C.
     POR = 1.-.01*FD
     DO 1C01  I=1,4
     FP(I)= -25.
1CC1 FQ(I)= 20.
1CC5 IF(KOCEF.NE.0) GO TO 1030
1CC6 CONTINUE
     DO 1020  I=1,8
     KODEF= I
1020 IF(FCODE.EQ.CODEF(I)) GC TO 1030
1030 GO 10 (1100,1100,1100,1200,1200,1200,1200,1300),KODEF
C********** NITRIDE FUELS
1100 CY= .195
     SFF= .85
     RBP= 1.3
     UDENS= 3.465E22
     FRHC= 14.32
     FTENS= 8.57E-3
     DO 1110 I=1,4
1110 FP(I) = -22.699 + 7.19E-4*(FT(I)-32.)
     C1=4.33E-6
     C2=4.03E-10
     C3=38.7
```

```
      C4=100.5
      C5=.284
      C6= -.382
      C7=.77351
      C8=1.9881E-4
      C9=6.0151E-8
      C10=-3.7144E-11
      C11=4.274E-15
      IF(MMM.EQ.1) GO TO 5000
      CF1=4.122E-12
      CF2=31088.
      NF=4.661
      IF(KODEF.NE.3)  GO TO 1400
      CF1=8.124E-16
      CF2=29893.
      NF= 5.903
      GO TO 1400
C********** CARBIDE FUELS
 1200 FTAVEF = 1.8*FTAVE-459.
      FTENS= 4.16E-3 - 3.17E-8*(FTAVEF-2414.)
      C1=5.16E-6
      C2=1.37E-9
      C3=32.6
      C5=.286
      C6=-.275
      C7=1.0049
      C8=-3.9255E-5
      C9=1.0710E-8
      C10=0.
      C11=0.
      GO TO (1400,1400,1400,1210,1220,1230,1240),KODEF
 1210 UDENS=3.325E22
      FRHC=13.63
      IF(MMM.EQ.1) GO TO 5000
      C4=74.9
      CF1=3.845
      CF2=36520.
      NF=1.58
      GO TO 1400
 1220 UDENS= 2.91E22
      FRHC=13.
      IF(MMM.EQ.1) GO TO 5000
      C1=4.82E-6
      C2=1.23E-9
      CF1=.371
      CF2=36520.
      NF=1.58
      GO TO 1400
 1230 UDENS= ZERO
      FRHC= ZERO
      IF(MMM.EQ.1) GO TO 5000
      CF1 = 1.E-10
      CF2 = 40000.
      NF = 4.
      GO TO 1400
 1240 UDENS= 3.2E22
      FRHC=13.63
      IF(MMM.EQ.1) GO TO 5000
      C1=5.04E-6
      C2=1.32E-9
```

```
      CF1=3.845
      CF2=36520.
      NF=1.58
      GO TO 1400
C********** OXIDE FUELS
 1300 UDENS= ZERO
      FRHC= ZERO
      IF(MMM.EQ.1) GO TO 5000
      CF1 = 1.E-10
      CF2 = 40000.
      NF = 3.
C         OTHERS LATER
 1400 CONTINUE
      IF(MMM.EQ.31) GO TO 830
      DO 1450  I=1,4
      FALPHA(I)= F3(C1,C2,FT(I))
      FE(I)=F2(C3,C4,POR,FT(I))
      FNU(I)= F3(C5,C6,POR)
      FK(I)= F4(C7,C8,C9,C10,C11,FT(I))
      FC(I)= F1(CF1,CF2,NF,DEGK(FT(I)))
 1450 FG(I)= NF
      IF(MMM.NE.2) GO TO 1999
      WRITE(6,3) FCODE
      DEBUG FTAVE,FD,POR,GS,STO
      DEBUG CY,SFF,RAP,RBP
      DEBUG UDENS,FRHC,FTENS
      DEBUG CF1,CF2,NF
      DEBUG FT(1),FT(2),FT(3),FT(4)
      DEBUG FALPHA(1),FALPHA(2),FALPHA(3),FALPHA(4)
      DEBUG FE(1),FE(2),FE(3),FE(4)
      DEBUG FNU(1),FNU(2),FNU(3),FNU(4)
      DEBUG FK(1),FK(2),FK(3),FK(4)
      DEBUG FC(1),FC(2),FC(3),FC(4)
      DEBUG FG(1),FG(2),FG(3),FG(4)
      DEBUG FP(1),FP(2),FP(3),FP(4)
      DEBUG FQ(1),FQ(2),FQ(3),FQ(4)
C********* INITIALIZE CLAD PARAMETERS
 1999 CONTINUE
      IF(CCODE.EQ.BLNK6) GO TO 2999
      SFC=0.
      CTENS=0.
      DO 2000  I=1,4
      CNU(I)= .3
      CP(I)=-25.
 2000 CQ(I)=20.
      C3=0.
      C4=0.
      C5=0.
      C8=0.
      C9=0.
      C10=0.
      C15=0.
      C16=0.
      C17=0.
      IF(KODEC.NE.0) GO TO 2002
 9999 CONTINUE
      DO 2001  I=1,23
      KODEC=I
 2001 IF(CCODE.EQ.CODEC(I)) GO TO 2002
 2002 CONTINUE
```

```
      IF(KODEC.GT.4) GO TO 2100
C********** TA ALLOYS
      IF(MMM.EQ.32) GO TO 2005
      SFC=EXP(-172.4-5.451E-2*CTAVE +1.128E-5*CTAVE **2+27.601*ALOG(CTAV
     1E))
      C1=2.414E-6
      C2=2.113E-9
      C3=-9.716E-13
      C4=2.105E-16
      C5=1.698E-20
      CRHC=16.7
      C13=2.0104
      C14=2.8459E-4
      C15=2.7727E-7
      C16=-1.2633E-10
      C17=1.3094E-14
 2005 CONTINUE
      GO TO (2010,2020,2030,2040),KODEC
 2010 CRHC= CRHO
      C6=26.1E6
      C7=-1700.
      CC1=2.214E-5
      CC2=47776.
      NC= 3.692
      DO 2011 I=1,4
      CP(I) = -31.27 + 3.194E-3*(CT(I)-32.)
 2011 CQ(I) = 15.1
      GO TO 2600
 2020 CRHC= CRHO
      C6=26.2E6
      C7=-1680.
      CC1=1.059E-8
      CC2=55194.
      NC= 4.995
      GO TO 2600
 2030 CRHC= CRHO
      C6=26.1E6
      C7=-1700.
      CC1=1.776E-6
      CC2= 27910.
      NC= 2.252
      GO TO 2600
 2040 CRHC= CRHO
      C1 = 2.3836E-6
      C2 = 1.2561E-9
      C3 =-1.9049E-13
      C4 =-4.0524E-17
      C5 = 8.7360E-21
      C6  =30.E6
      C7 = -5500.
      CC1 = 1.E-10
      CC2 = 40000.
      NC = 3.
      GO TO 2600
 2100 IF(KODEC.GT.7)  GO TO 2200
C********** NB ALLOYS
      CRHC= 8.57
      C1 = 3.813E-6
      C2 = 2.522E-10
      IF(KODEC.EQ.7)  GO TO 2150
```

```
      C6 = 11.8E6
      C7 = -3667.
      CC1= 3.88E-11
      CC2= 44604.
      NC= 5.988
      IF(KODEC.EQ.6)  CC1= 5.717E-15
      IF(KODEC.EQ.6)  CC2 = 42700.
      C13= 2.2045
      C14= 4.8329E-4
      C15= -3.8383E-8
      GO TO 2600
 2150 C6 = 1.6522E7
      C7 = -7.996E3
      C8 = 3.397
      C9 = 4.05E-4
      C10= -3.21E-7
      C13= 2.8968
      C14= 4.1360E-5
      CC1= 1.482E-3
      CC2= 32069.
      NC= 2.120
      GO TO 2600
 2200 IF(KODEC.GT.9)  GO TO 2300
C********* MO ALLOYS
      CRHC= 10.2
      C1 = 3.E-6
      C2 = 3.E-10
      C6 = 50.E6
      C7 = -11000.
      C13= 6.8843
      C14= -9.4425E-4
      C15= -1.4765E-7
      C16= 3.8009E-11
      CC1= 5.190E-1
      IF(KODEC.EQ.9)  CC1=2.54E-3
      CC2= 57021.
      IF(KODEC.EQ.9)  CC2=84041.
      NC= 2.669
      IF(KODEC.EQ.9)  NC= 4.221
      GO TO 2600
 2300 IF(KODEC.GT.12)  GO TO 2400
C********* W-RE ALLOYS
      CRHC= 19.3
      C6 = 62.8E6
      C7 = -4667.
      IF(KODEC.EQ.12)  GO TO 2350
      C1 = 2.22E-6
      C2 = 3.52E-10
      C13= 2.7946
      C14= 1.7253E-4
      CC1= 3.952E-5
      CC2= 45676.
      NC= 3.377
      GO TO 2600
 2350 C1 = 2.45E-6
      C2 = 3.46E-10
      C13 = 3.1812
      C14 = 1.90775E-4
      CC1= 3.946E-6
      CC2= 45860.
```

```
      NC= 3.861
      GO TO 2600
 2400 IF(KODEC.GT.13)  GO TO 2500
C********* STAINLESS STEEL
      CRHC= 7.9
      C1  =  ZERO
      C2  =  ZERO
      C6  =  ZERO
      C7  =  ZERO
      C11=  ZERO
      C12=  ZERO
      C13=  ZERO
      C14=  ZERO
      CC1  =  1.E-10
      CC2  =  40000.
      NC   =  4.
      GO TO 2600
C********* TUNGSTEN MATERIALS
 2500 CRHC= 19.3
      C1  =  2.175E-6
      C2  =  2.25E-10
      C6  =  50.E6
      C7  =  -8333.
      C13=  6.2303
      C14=  -4.1243E-4
      IF(KODEC.GT.16)  GO TO 2510
C********* STANDARD TUNGSTEN
 2501 CC1= 1.53E-8
      CC2= 49211.
      NC= 4.391
      GO TO 2600
 2510 IF(KODEC.GT.17) GO TO 2520
C********* PLAIN CVDW
 2511 CC1= 46.80
      CC2= 49000.
      NC= 1.26
      GO TO 2600
 2520 IF(KODEC.GT.20) GO TO 2530
C********* CVDW W/ KNOWN METHOD
      GO TO 2511
 2530 IF(KODEC.GT.22) GO TO 2540
C********* CVDW W/ KNOWN FLUORINE CONTENT
      GO TO 2511
 2540 CONTINUE
C********* W WITH UNKNOWN OR COMPLEX COMP.
      GO TO 2501
 2600 CONTINUE
      IF(MMM.EQ.32) GO TO 840
      DO 2610  I=1,4
      CALPHA(I)= F4(C1,C2,C3,C4,C5,CT(I))
      CE(I)=  F4(C6,C7,C8,C9,C10,CT(I))
      CO= CT(I)
      IF(KODEC.EQ.1) CNU(I)= .26085-1.978E-5*CO-9.63E-9*CO**2+8.74E-12*
     1                 CO**3
      CK(I)= F4(C13,C14,C15,C16,C17,CT(I))
      CC(I)= F1(CC1,CC2,NC,DEGK(CT(I)))
 2610 CG(I)= NC
      IF(MMM.NE.2) GO TO 2999
      WRITE(6,3) CCODE
      DEBUG CTAVE
```

```
      DEBLG SFC,CTENS,CRHO
      DEBLG CC1,CC2,NC
      DEBLG CT(1),CT(2),CT(3),CT(4)
      DEBLG CALPHA(1),CALPHA(2),CALPHA(3),CALPHA(4)
      DEBLG CE(1),CE(2),CE(3),CE(4)
      DEBLG CNU(1),CNU(2),CNU(3),CNU(4)
      DEBLG CK(1),CK(2),CK(3),CK(4)
      DEBLG CC(1),CC(2),CC(3),CC(4)
      DEBLG CG(1),CG(2),CG(3),CG(4)
      DEBLG CP(1),CP(2),CP(3),CP(4)
      DEBLG CQ(1),CQ(2),CQ(3),CQ(4)
C********* GAS CONDUCTIVITIES -- IF UNKNOWN , USES XENON
 2999 CONTINUE
      IF(GCODE.EQ.BLNK6.AND.MMM.EQ.2) GO TO 3999
      IF(KODEG.NE.0) GO TO 3001
      DO 3000  I=1,9
      KODEG= I
 3000 IF(GCODE.EQ.CODEG(I))  GO TO 3001
 3001 GO TO (3010,3020,3030,3040,3050,3060,3070,3080,3050), KODEG
 3010 C1 = 1962.8
      C2 = 20.775
      C3 = -8.315E-3
      C4 = 2.618E-6
      C5 = -3.261E-10
      GO TO 3100
 3020 C1 = 538.795
      C2 = 6.5725
      C3 = -2.7268E-3
      C4 = 8.7028E-7
      C5 = -1.0909E-10
      GO TO 3100
 3030 C1 = 94.996
      C2 = 2.8424
      C3 = -1.3465E-3
      C4 = 4.5422E-7
      C5 = -5.8717E-11
      GO TO 3100
 3040 C1 = 1.0920
      C2 = 1.6829
      C3 = -7.2180E-4
      C4 = 2.1933E-7
      C5 = -2.6071E-11
      GO TO 3100
 3050 C1 = -10.2409
      C2 = 1.0312
      C3 = -4.1588E-4
      C4 =  1.2352E-7
      C5 = -1.4732E-11
      GO TO 3100
 3060 C1 = 343.366
      C2 = 1.954
      C3 = 5.232E-4
      C4 = -1.3516E-7
      C5 = 1.0809E-11
      GO TO 3100
 3070 C1 = 245.42
      C2 = 2.0914
      C3 = 3.1215E-4
      C4 = 2.752E-8
      C5 = -2.2892E-11
```

```
      GO TO 3100
 3080 C1 = 241.67
      C2 = 3.5176
      C3 = -6.6034E-4
      C4 = 1.3842E-7
      C5 = -1.5621E-11
 3100 C6 = CTAVE
      CGAP=(F4(C1,C2,C3,C4,C5,C6))*1.E-6
C********* XE VDW GAS CONSTANTS
      RVDW= 1.85E4
      AVDW= 1.42E3
      BVDW = 4.63E10
      IF(MMM.NE.2) GO TO 3999
      WRITE(6,3) GCODE
      DEBUG CTAVE
      DEBUG CGAP,RVDW,AVDW,BVDW
C********* PLUG DENSITY
 3999 CONTINUE
      IF(PCODE.EQ.BLNK6.AND.MMM.EQ.2) GO TO 5000
      IF(KODEP.NE.0) GO TO 4001
      DO 4000  I=1,7
      KODEP= I
 4000 IF(PCODE.EQ.CODEP(I))  GO TO 4001
 4001 CONTINUE
      IF(KODEP.EQ.1)  PRHO= 10.2
      IF(KODEP.EQ.2)  PRHO=  7.9
      IF(KODEP.EQ.3)  PRHO= 16.6
      IF(KODEP.EQ.4)  PRHO= 19.3
      IF(KODEP.EQ.5)  PRHO=  8.57
      IF(KODEP.EQ.6)  PRHO= 20.5
      IF(KODEP.EQ.7)  PRHO=  0.
      IF(MMM.NE.2) GO TO 5000
      WRITE(6,3) PCODE
      DEBUG PRHO
 5000 CONTINUE
      RETURN
      END
$IBFTC CYCRD    DEBUG,DECK
      SUBROUTINE CYCARD
      REAL NFA,NCA,MCORE,MGAS,NGF,NB,MMM,NNN,MCGPQ,MNHT,MOLES1,MOLES(24)
      REAL NH,NHT,KR1,KR2,KR3,KR4,NRF,NRC,NGC
      DIMENSION TG(3),CNUM(50),VSTM(100),VSTC(100),PGAP(100),TWATER(100)
     1,          TIME(100),RF(20),RC(20),TITLE(14),F(100)
      COMMON/COM1/EXNUM,RCYC,RB,RMC,RMF,RA,RP,RPI,FL,CL,VF,NREFS,FCODE,        13
     1            CCODE,PCODE,GCODE,FD,CD,GS,ENR,STO,P,PWATER,ID(4),           27
     1            DATE(2),REFNOS(8),FTYPE(2),CTYPE(2),TTOT,TCTOT,BDOTAV,       44
     1            GRDRAV,GRDZAV,GAMAV,FFXAV,TFXAV,RAV,TFOAV(3),TFIAV(3),       56
     1            TCAV(3),DRMFAV(3),DRAAV(3),DFLAV(3),DVAV(3),DRBAV(3),        74
     1            DCLAV(3),COMM(20,13),NCOMM,CODE(10),CDATE(10),              358
     1            FNUM(10),CALC(10,9),RMRKS(30,11),BU,NOTES(8),               797
     1            QFUEL,CTAVE,FTAVE,                                          800
     1            CYCT(60),THCYC(60),GRADR(60),GRADZ(60),BDOT(60),           1100
     1            GAMMA(60),FFLUX(60),TFLUX(60),R(60),TFO(60,3),             1520
     1            TFI(60,3),TC(60,3),DRMF(60,3),DRA(60,3),DFL(60,3),         2420
     1            DV(60,3),DRB(60,3),DCL(60,3)                               2960
      COMMON/COM2/CY,SFF,RAP,RBP,FP(4),FQ(4),UDENS,FRHO,FTENS,CF1,CF2,NF
     1,           FALPHA(4),FE(4),FNU(4),FK(4),FC(4),FG(4),SFC,CTENS
     1,           CP(4),CQ(4),CNU(4),CRHO,CC1,CC2,NC,CALPHA(4),CE(4)
     1,           CK(4),CC(4),CG(4),CGAP,RVDW,AVDW,BVDW,PRHO
      COMMON/COM3/FT(4),CT(4),KODEF,KODEC,KODEG,KODEP
```

```
      DATA CNE,Z,    TAMB,TONE,TTWO/1.,0.0,     70.,.001,1./
      NAMELIST/CYG1/NCYGRO,FT,CT,NB,PP,NFA,NCA,NT,DELT,FRLS,P,
     1              PWATER,GAMAV,KODEF,KODEC,KODEP,KODEG,GS,VF,BDOTAV,
     1              CTAVE,FTAVE,CD
      NAMELIST/CYG2/CGAP,HGAP,HNOGAP,HWATER,RVDW,AVDW,BVDW,MCORE,RAP,
     1              RBP,FTENS,MOLES1,AM,BM,VGH,RQ1,RQ2,RQ3,RQ4,KR1,KR2,
     1              KR3,KR4,QRATIO
  100 FORMAT(8E10.5)
  101 FORMAT(8F10.0)
  102 FORMAT(10F8.0)
  103 FORMAT(2F5.0,3E10.6)
  104 FORMAT(5I5)
  105 FORMAT(2H* ,8E8.3,F8.0)
  106 FORMAT(1H0)
  107 FORMAT(2H* ,5E8.3,24X,F8.0)
  108 FORMAT(10A6)
  109 FORMAT(1H1,26X,19H 9 0 0     C A R D S)
  110 FORMAT(1H1,26X,19H 1 0 0 0   C A R D S)
  111 FORMAT(2H* ,F8.5,56X,F8.0)
  112 FORMAT(2H* ,3(8H        1),3(8H  .33333),16X,F8.0)
  113 FORMAT(2H* ,3E8.3,40X,F8.0)
  114 FORMAT(2H* ,F8.0,4E8.3,3(8H        1),F8.0)
  115 FORMAT(2H* ,8X,4F8.4,24X,F8.0)
  116 FORMAT(1H1,26X,19H 2 0 0 0   C A R D S)
  117 FORMAT(1H1,26X,26H H I S T O R Y   C A R D S//4X,68HVSTM     VSTC
     2  FDOT      F       PGAP    PWATER QG/QGMAX TWATER    TIME)
  118 FORMAT(1H1,10X,11HGAS RELEASE)
  119 FORMAT(1H0,11HITERATIONS=,I2,5X,23HFRACTIONAL GAS RELEASE=,F6.4)
  120 FORMAT(2H* ,8E8.3,F8.3)
  121 FORMAT(1HL,27HMISC. CALCULATED PARAMETERS)
  122 FORMAT(1HL,22HMISC. INPUT PARAMETERS)
  123 FORMAT(2H* ,7E8.3,2F8.0)
  124 FORMAT(A2,13A6)
  125 FORMAT(1H1,///2H* A2,13A6)
      KODEF=0
      KODEP=0
      KODEG=0
      KODEC=0
      NFA=10
      NCA=5
      NT=0
      DELT=0.
      FRLS=0.
      IF(CD.EQ.0.) CD = 100.
      SI1 = 2.54
      SI2 = 459.
      SI3 = 1.8
      SI4 = SI1**3
      SI5 = 1.E20/SI4
      SI6 = 56.0
      SI7 = 12.242
      SI8 = .6895
      SI9 = 454.
      READ(5,124) TITLE
      WRITE(6,125) TITLE
      WRITE(6,122)
      READ(5,CYG1)
      WRITE(6,CYG1)
      CALL PROPS
      DEBUG FTENS,GS,FRLS
```

```
      DEBLG FD,CD
      DEBLG CGAP,HGAP,HNOGAP
      DEBLG HWATER,PWATER,P
      DEBLG GAMAV,BU,DELT
      DEBLG RB,RMC
      DEBLG RMF,RA
      DEBLG RP,RPI
      DEBLG NFA,NCA
      DEBLG VF,MCORE,MGAS
      DEBLG NT,NB,PP
C********** SET UP TIMES AND TEMPERATURES.
      IF(NT.EQ.0) GO TO 241
      DEL = TTOT/FLOAT(NT)
      TIME(1)=DEL
      DO 240 I=2,NT
      J=I-1
      TIME(I)=TIME(J)+DEL
  240 CONTINUE
      GO TO 260
  241 CONTINUE
      J=IFIX(RCYC)
      TIME(1)=CYCT(1)
      DO 250 I=2,J
  250 TIME(I)=TIME(I-1) + CYCT(I)
  260 CONTINUE
      DO 265 I=1,NT
  265 TWATER(I)=SI3*CTAVE-SI2
C**********  9 0 0  C A R D S
CARD 900
      WCS=30.
      F1=C.
      F2=1.E1
      F3=1.E3
      FDOT1=1.E-8
      FDOT2=1.E-6
      FDOT3=1.E-4
      RUNLIM=.5
CARDS 90K  K=1,2,3   DFT*S AND RGASN = 1 --- ZUYKB = 0
      TG(1)=0.
      TG(2)=1.E3
      TG(3)=3.E3
CARD 904
      HGAP  =1.E10
      HNOGAP=1.E10
      HWATER=1.E10
      IF(DELT.EQ.0.) GO TO 268
      HGAP =  QFUEL*(RMF**2-RA**2)/DELT/2./RMF*SI7
      HNOGAP = HGAP
      CGAP  =1.E10
  268 CONTINUE
      TABS=SI2
CARD 905   THE THREE F*S = 0.
      DSMAX=2.E3
      DEMAX=1.E-3
      TPLUG=5.E3
      RPLUG=RP/SI1
      IF(RPLUG.LT.1.E-5) GO TO 270
      CON1=(RPI/RP)**2
      QPLUG=GAMAV*PRHO*(1.-CON1)*SI6
      GO TO 271
```

```
  270 QPLLG=0.
  271 CONTINUE
CARD 906
C       SGMIN,MGL,PFILE = 1 --- MPQ,EDOGS,MFILE = 0
      MGAS =0.
      MCORE=1.
      IF(RA.EQ.0.) MCORE=0.
CARD 907   MCEE,HIST,MAXC = 0.
      DVMAX=1.E-3
      MMM=1.E3
      NNN=1.E3
C**********  1 0 0 0   C A R D S
CARD 1000
      NRF=NFA+1.
      NGF=1.
      RSC=1.
      RSP=1.
      MCGFQ=2.
      QGMAXF=QFUEL*SI6
      EZ=C.0
CARD 1001     ALL ZEROES EXCEPT RADII
      NLIM=NRF
      CON5=(RMF-RA)/NFA
      DO 310 I=1,NLIM
      RF(I)=(RMF-CON5*(NFA-FLOAT(I-1)))/SI1
  310 CONTINUE
CARD 1002
      VH=1.-.01*FD
      MOLES1= 4.405E-6*PP*VH*SI4/SI9*SI8
      AM=7.31E-7*CY
      VG=1.
      MNHT=0.0
      NH=NB*SI4
      NHT=NH
      PI=3.14159
      FDOT=.01*BDOTAV*UDENS*.01*FD/SI5
      TSEC=3600.*TTOT
      IF(FRLS.GT.0.) GO TO 340
      FRLS=.01*RAV
      IF(FRLS.EQ.0.) GO TO 360
      IF(KODEF.LE.3) GO TO 320
      CON1=(RMF-RA)
      CON3=-17450./FTAVE
      CON4=EXP(CON3)
      FRLS=.231*SQRT(TSEC)*CON4/CON1
      GO TO 340
  320 CONTINUE
      Y=5.E-5*GS
      CON5=FDOT*SI5/3600.
      CON6=CON5*1.35E-30
      CON7=EXP(-18818./FTAVE)
      CON8=CON7*4.32E-9
      ALPHA=((CON6+CON8)*CON2*(PI**2))/(4.*Y**2)
      IF(ALPHA.LE.1.) GO TO 330
      CON1= 8./PI**2/ALPHA
      CON2= EXP(-ALPHA)
      CON3= (EXP(-9.*ALPHA))/81.
      FGAS=1.-CON1*(1.014362-CON2-CON3)
      GO TO 331
  330 FGAS=.479*SQRT(ALPHA)
```

```
  331 FMIN=2.*Y/(RMF-RA) /FGAS
      FRLS=FMIN
      IF(BU.GT.2.5) FRLS=FGAS
      IF(BU.GE..65.AND.BU.LT.2.5.AND.FTAVE.GT.1430.)FRLS=FMIN*(1.+16.3*
     1 BU)
  340 CONTINUE
      IF(FRLS.LT.1.) BM=3.E-3
      IF(FRLS.LE..95) BM=3.E-4
      IF(FRLS.LE..75) BM=7.E-5
      IF(FRLS.LE..5) BM=3.E-5
      IF(FRLS.LE..30) BM=7.E-6
      IF(FRLS.LE..1) BM=3.E-6
      IF(FRLS.LE..05) BM=7.E-7
      IF(FRLS.LE..01)   BM=3.E-7
      CON12=1./TTOT
      CON14=1.-FRLS
      DO 350 I=1,20
      CON15=BM*TTOT
      ITR=I
      CON16=1.-EXP(-CON15)
      FX = CON16/CON15-CON14
      DFDX = EXP(-CON15)/BM - CON16/BM/CON15
      DEBUG ITR,FX,DFDX
      DEBUG BM
      IF(ABS(FX).LT.1.E-8) GO TO 370
      BM=BM-FX/DFDX
  350 CONTINUE
      GO TO 370
  360 BM=1.E-15
  370 CONTINUE
CARD 1003   ASSUME ISOTROPIC MATL
CARD 1004
      P1=0.0
      P2=6.E3
      P3=1.E4
CARD 1005   ASSUME NO RADIAL VARIATION
      KR1=1.
      KR2=NRF
      KR3=0.
      KR4=0.
      RQ1=1.
      RQ2=1.
      RQ3=0.
      RQ4=0.
CARDS 10JK  J=1,4  K=0,3
C     RVP'S = 1 FOR ALL 10JK CARDS
C     CREEP CONSTANTS THE SAME FOR ALL 10JK CARDS FOR A PARTICULAR J.
C     LIMIT CREEP 'C' CONSTANT TO -25.
      DO 380 I=1,4
  380 IF(FC(I).LT.-25.) FC(I)=-25.
C********** 2 0 0 0   C A R D S
CARD 2000 RSC,RSP,MCGPQ,EZ SAME AS 1000 CARD
      NRC=NCA+1.
      NGC=0.
      QGMAXC=.01*GAMAV*CRHO*CC*SI6
CARD 2001    ALL ZEROES EXCEPT RADII
      NLIM=NRC
      CON6=(RB-RMC)/NCA
      DO 410 I=1,NLIM
  410 RC(I) = (RB-CON6*(NCA-FLOAT(I-1)))/SI1
```

```
CARDS 2002 --- OMIT
CARDS 2003 TO END -- SAME ASSIGNED VARIABLES AS CORRESP. 1000 CARDS, EXCEPT--
      CTENS=1.
      DO 420 I=1,4
  420 IF(CC(I).LT.-25.) CC(I)=-25.
C********** H I S T O R Y   C A R D S
      CON7=SFF*.01*BU/TIME(NT)
      CON77=SFC*1.E20/FD/UDENS*1.018E20
      VTWC=CON7*1.
      FTWC=FDOT*1.
      PTWC=P*(TWATER(NT)+ SI2)/(TAMB+ SI2)
      DO 510 I=1,NT
      F(I)=FDOT*TIME(I)
      VSTM(I)=CON7*TIME(I)
      VSTC(I)=CON77*F(I)
      CONE=EXP(-BM*TIME(I))
      CONS=AM*F(I)
      CON10=MOLES1-AM*FDOT/BM
      CON11=CON9+(1.-CON8)*CON10
      PGAP(I)=1.86E4*CON11*(TWATER(I)+459.)/VF + PTWO
  510 CONTINUE
      TLAST=TIME(NT)+1.
      PLAST=PGAP(NT)*(TAMB+ SI2)/(TWATER(NT)+ SI2)
      READ(5,CYG2)
      WRITE(6,CYG2)
C *****  P U N C H   C A R D S
      N=0
      DO 610 I=900,907
      N=N+1
  610 CNUM(N)=FLOAT(I)
C***** WRITE 900 CARDS
      WRITE(6,109)
      WRITE(6,106)
      WRITE(6,105) WCS,F1,F2,F3,FDOT1,FDOT2,FDOT3,RUNLIM,CNUM(1)
      DO 615 I=1,3
      J=I+1
  615 WRITE(6,107) TG(I),ONE,ONE,ONE,ONE,CNUM(J)
      WRITE(6,105) CGAP,HGAP,HNOGAP,HWATER,RVDW,AVDW,BVDW,TABS,CNUM(5)
      WRITE(6,105) Z,Z,Z,DSMAX,DEMAX,RPLUG,QPLUG,TPLUG,CNUM(6)
      WRITE(6,105) ONE,Z,MCORE,MGAS,ONE,Z,Z,ONE,CNUM(7)
      WRITE(6,105) Z,DVMAX,Z,RAP,RBP,Z,MMM,NNN,CNUM(8)
      DO 620 I=1000,1005
      J=I-999
  620 CNUM(J)=FLOAT(I)
      LLL=6
      DO 622 J=1,4
      DO 621 K=1,4
      L=K-1
      LLL=LLL+1
      CNUM(LLL)=FLOAT(1000+10*J+L)
  621 CONTINUE
  622 CONTINUE
C***** WRITE 1000 CARDS
      WRITE(6,110)
      WRITE(6,106)
      WRITE(6,105) NRF,NGF,RSC,RSP,MCGPQ,QGMAXF,EZ,FTENS,CNUM(1)
      NLIM=NRF
      DO 623 I=1,NLIM
  623 WRITE(6,111) RF(I),CNUM(2)
      WRITE(6,105)   MOLES1,AM,BM,VH,VG,NH,MNHT,NHT,CNUM(3)
```

```
      WRITE(6,112) CNUM(4)
      WRITE(6,113) P1,P2,P3,CNUM(5)
      WRITE(6,105) KR1,RQ1,KR2,RQ2,KR3,RQ3,KR4,RQ4,CNUM(6)
      LLL=6
      DO 625 J=1,4
      LLL=LLL+1
      WRITE(6,114) FT(J),FALPHA(J),FE(J),FNU(J),FK(J),CNUM(LLL)
      DO 624 K=1,3
      LLL=LLL+1
      WRITE(6,115) FC(J),FG(J),FP(J),FQ(J),CNUM(LLL)
  624 CONTINUE
  625 CONTINUE
      DO 630 I=2000,2005
      J=I-1999
  630 CNUM(J)=FLOAT(I)
      LLL=6
      DO 632 J=1,4
      DO 631 K=1,4
      L=K-1
      LLL=LLL+1
      CNUM(LLL)=FLOAT(2000+10*J+L)
  631 CONTINUE
  632 CONTINUE
C***** WRITE 2000 CARDS
      WRITE(6,116)
      WRITE(6,106)
      WRITE(6,105) NRC,NGC,RSC,RSP,MCGPQ,QGMAXC,EZ,CTENS,CNUM(1)
      NLIM=NRC
      DO 633 I=1,NLIM
  633 WRITE(6,111) RC(I),CNUM(2)
      WRITE(6,112) CNUM(4)
      WRITE(6,113) P1,P2,P3,CNUM(5)
      WRITE(6,105) ONE,ONE,NRC,ONE,Z,Z,Z,Z,CNUM(6)
      LLL=6
      DO 635 J=1,4
      LLL=LLL+1
      WRITE(6,114)CT(J),CALPHA(J),CE(J),CNU(J),CK(J),CNUM(LLL)
      DO 634 K=1,3
      LLL=LLL+1
      WRITE(6,115) CC(J),CG(J),CP(J),CQ(J),CNUM(LLL)
  634 CONTINUE
  635 CONTINUE
C***** WRITE HISTORY CARDS
      WRITE(6,117)
      WRITE(6,106)
      WRITE(6,120) Z,Z,Z,Z,P,PWATER,Z,TAMB,TONE
      WRITE(6,120)VTWC,Z,FDOT,FTWO,PTWO,PWATER,ONE,TWATER(1),TTWO
      DO 640 I=1,NT
      WRITE(6,123)VSTM(I),VSTC(I),FDOT,F(I),PGAP(I),PWATER,ONE,TWATER(I)
     1,             TIME(I)
  640 CONTINUE
      WRITE(6,123) VSTM(NT),VSTC(NT),Z,F(NT),PLAST,PWATER,Z,TAMB,TLAST
      WRITE(6,118)
      WRITE(6,119) ITR,FRLS
      WRITE(6,121)
      DEBUG FTAVE,B
      DIF(KODEF.LE.3) DEBUG ALPHA,FGAS,FMIN
      DEBUG FDOT,AM,BM
      DEBUG MOLES1,CON8,CON9
      DEBUG CON10,CON11
```

```
      RETURN
      END
$IBFTC SUBR1    DEBUG,DECK
      SUBROUTINE SUB1
C
C                SUB1 USED WHEN MAIN ARRAY OF EXP. INFORMATION IS DESIRED.
C                SUB2 USED WHEN ONLY SUMMARY SHEET DATA IS DESIRED.
C
      DIMENSION SUMM(30)
      COMMON/COM1/EXNUM,RCYC,RB,RMC,RMF,RA,RP,RPI,FL,CL,VF,NREFS,FCODE,      13
     1           CCODE,PCODE,GCODE,FD,CD,GS,ENR,STO,P,PWATER,ID(4),          27
     1           DATE(2),REFNOS(8),FTYPE(2),CTYPE(2),TTOT,TCTOT,BDOTAV,      44
     1           GRDRAV,GRDZAV,GAMAV,FFXAV,TFXAV,RAV,TFOAV(3),TFIAV(3),      56
     1           TCAV(3),DRMFAV(3),DRAAV(3),DFLAV(3),DVAV(3),DRBAV(3),       74
     1           DCLAV(3),COMM(20,13),NCOMM,CODE(10),CDATE(10),             358
     1           FNUM(10),CALC(10,9),RMRKS(30,11),BU,NOTES(8),              797
     1           QFUEL,CTAVE,FTAVE,                                          800
     1           CYCT(60),THCYC(60),GRADR(60),GRADZ(60),BDOT(60),           1100
     1           GAMMA(60),FFLUX(60),TFLUX(60),R(60),TFO(60,3),             1520
     1           TFI(60,3),TC(60,3),DRMF(60,3),DRA(60,3),DFL(60,3),         2420
     1           DV(60,3),DRB(60,3),DCL(60,3)                               2960
      COMMON/COM2/CY,SFF,RAP,RBP,FP(4),FQ(4),UDENS,FRHO,FTENS,CF1,CF2,NF
     1,          FALPHA(4),FE(4),FNU(4),FK(4),FC(4),FG(4),SFC,CTENS
     1,          CP(4),CQ(4),CNU(4),CRHO,CC1,CC2,NC,CALPHA(4),CE(4)
     1,          CK(4),CC(4),CG(4),CGAP,RVDW,AVDW,BVDW,PRHO
      COMMON/COM3/FT(4),CT(4),KODEF,KODEC,KODEG,KODEP
      COMMON/COM4/NTOT,NNN,SUMM,KSUB2
C**********    SUB1 FORTRAN FOLLOWS UP TO STMT. 999
  999 CONTINUE
      GO TO 2000
      ENTRY SUB2
      N=IFIX(SUMM(20))
C**********  N IS EXPERIMENT SUMMARY NUMBER.
C**********  SUB2 FORTRAN HERE, UP TO STMT 2000
 2000 CONTINUE
      RETURN
      END
```

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17. ADVANCED MATERIALS PROGRAM, MAR/APR 64. PWAC-1014,PRATT/WHITNEY.
18. ADVANCED MATERIALS PROGRAM, NOV/DEC 64. PWAC-1018,PRATT/WHITNEY.
19. WEAVER,SC ET AL.EFFECTS OF IRRAD ON UN. ORNL-4461,OAK RIDGE, 10/69
20. WEINSTEIN.FISS GAS REL FROM UN AT HIGH FISS RATE DENS.NASA TN-D-7171
21. ALBRECHT ET AL.HIGH-TEMP IRRAD + POST-IRR ANAL OF UN. UCRL-50727.8/7/69
22. ADVANCED MATERIALS PROGRAM, NOV/DEC 63. PWAC-1012,PRATT/WHITNEY.2/21/64
23. ADVANCED MATERIALS PROGRAM, JUL/AUG 64. PWAC-1016,PRATT/WHITNEY.11/11/64
24. ADVANCED MATERIALS PROGRAM, SEP/OCT 64. PWAC-1017,PRATT/WHITNEY.12/17/64
25. PATRIARCA.FUELS AND MATLS DEV PROGRAM QPR TO 6/30/69.ORNL-4440. OCT 69
26. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 9/30/69. ORNL-4480. FEB 70
27. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 12/31/69.ORNL-4520. MAY 70
28. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 3/31/70. ORNL-4560. AUG 70
29. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 6/30/70. ORNL-4600. NOV 70
30. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 9/30/70. ORNL-4630. MAR 71
31. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 12/31/70.ORNL-TM-3300.JUL 71
32. PATRIARCA.FUELS AND MATLS DEV PROG QPR TO 6/30/71.ORNL-TM-3540. SEP 71
33. WEAVER.20TH HIGH-TEMPERATURE FUELS COMMITTEE MTG.ORNL-CF-68-4-33.4/19/68
34. DAVISON/FIERO.CALC OF UN SWELLING WITH CYGRO-2.NASA TM-X-2224. 3/71
35. DEV OF A THERMIONIC REACTOR SPACE POWER SYSTEM.GACD-6130(3/72).4/19/72
36. DICKERSON/CHUBB.DEV OF ADV HIGH-TEMP NUC MATLS MAY-JUL63.BMI-1645.8/1/63
37. KELLER/CHUBB.DEV OF ADV HIGH-TEMP NUC MATLS FEB.APR 67.BMI-1773.5/1/66
38. THERMIONIC CONV AND FUEL ELEMENT TEST SUMMARIES. GULF-GA-C12118.5/25/72
39. DEV. OF A THERMIONIC REACTOR SPACE POWER SYSTEM. 3-6/69 .GA-9594.8/13/70
40. ROUGH.PROP OF FUELS FOR COMPACT NUC SPACE REACTORS.LOG-C04078.BMI.9/66
41. CUNEO ET AL.EXAM OF IRRAD UN FUEL CLAD W/ W-RE OR T-111.ORNL-TM-3895 72
42. KELLER/CHUBB.DEV OF ADV HIGH TEMP NUC MATLS 11/66-1/67.BMI-1631.5/1/63
43. R/D ON FISS-HTD THERMIONIC CELLS FOR APPL TO NUCLEAR SPS. GA-8965.1/6/69
44. POST-OPERATIONAL EXAMS OF TWO CARBIDE-FUELED IN-PILE CONV.GA-11004.SEP69
45. IN-PILE THERMIONIC TESTING AT GULF GENERAL ATOMIC.GACD-11000.FEB 71
46. DEV OF A THERMIONIC REACTOR SPACE POWER SYSTEM.GACD-6130(5/72).
47. DEV OF A THERMIONIC REACTOR SPACE POWER SYSTEM.GACD-6130(6/72).
48. IN-PILE THERMIONIC TESTING AT GULF GENERAL ATOMIC.GULF-GA-C11062.OCT 71
49. R/D ON FISS-HTD THERMIONIC CELLS FOR APPL TO NUC SPS.GA-7499.10/65-9/66
50. THERMIONIC CONV AND FUEL ELEMENT TEST SUMMARIES. GA-C-2147(9/71).11/71

51. DEV CF A THERMIONIC REACTOR SPACE POWER SYSTEM.GACD-6130(9/72).10/25/72
52. DEV CF A THERMIONIC REACTOR SPACE POWER SYSTEM.GACD-6130(10/72).11/15/72
53. SMITH,JR. IRRAD. OF UC FUEL FORMS. NASA TM-X-52696. 10/23/69
54. SMITH,JR. IRRAD. OF (U,ZR)C FUEL TO 11000 HRS. NASA TM-X-52913. 10/26/70
55. SMITH,JR.EXAM OF UC-ZRC AFTER LONG-TERM IRRAD.NASA-CR-120995. 12/21/72
56. GULF-GA RADIOGRAPH FINDINGS AFTER JUNE 1972 SHUTDOWN.
57. URANIUM NITRIDE FUEL DEVELOPMENT - SNAP 50. REPT. PWAC-488. OCT. 1965

** SYMBOLS AND ABBREVIATIONS **

*	FUELS
*	
UC	URANIUM CARBIDE
U1CZRC	UC WITH 10 MOLE PERCENT ZRC PLUS 4 W/O TUNGSTEN
U5CZRC	UC WITH 50 MOLE PERCENT ZRC PLUS 4 W/O TUNGSTEN
UC+4W	UC PLUS 4 W/O TUNGSTEN
UN	URANIUM NITRIDE, UNKNOWN OXYGEN CONTENT
UN-HI	UN WITH HIGH OXYGEN CONTENT (.GT. 1000 PPM)
UN-LO	UN WITH LOW OXYGEN CONTENT (.LE. 1000 PPM)
UO2	URANIUM DIOXIDE
*	
*	CLADS
*	
CVDW	CHEMICALLY-VAPOR-DEPOSITED TUNGSTEN
FCVDW	CVD TUNGSTEN, FROM THE FLUORIDE
CCVDW	CVD TUNGSTEN, FROM THE CHLORIDE
DCVDW	DUPLEX CVD TUNGSTEN (FCVDW + CCVDW LAYERS)
D-43	NIOBIUM - 9W- 1ZR
NB-1ZR	NIOBIUM- 1ZR
PWC-11	NIOBIUM- 1ZR- .1C
SS	STAINLESS STEEL
T-111	TANTALUM- 8W- 2HF
TZM	MOLYBDENUM- .5TI- .08ZR- .03C
W-26RE	TUNGSTEN- 26RHENIUM
WALLOY	TUNGSTEN ALLOY OF UNKNOWN OR COMPLEX COMPOSITION
W-REMO	TUNGSTEN- 25RE- 30MO
*	
*	ORGANIZATIONS
*	
BMI	BATTELLE MEMORIAL INSITTUTE
GGA	GULF GENERAL ATOMIC
LRL	LAWRENCE RADIATION LAB
PBRF	NASA-PLUM BROOK REACTOR FACILITY
PW	PRATT AND WHITNEY
ORNL	OAK RIDGE
*	
*	EXPERIMENT PARAMETER SYMBOLS
*	
A/O	ATOM PERCENT
BDOT	BURNUP RATE, ATOM PER CENT PER HOUR
BURNUP	BASED ON ORIGINAL URANIUM
CAPS.	CAPSULE
CL	CLAD LENGTH
DX/X	CHANGE IN X VARIABLE, PERCENT (MAX,MIN,AVG REFERS TO GEOMETRY).
DD/D	CLAD OD INCREASE, PERCENT
DV/V	FUEL VOLUME INCREASE, PERCENT
DIAM.	CLAD OD, FUEL ID(HOLE)
FL	FUEL LENGTH
GAMMA	GAMMA HEATING RATE, WATT/GRAM
GRADR	RATIO OF MAX TO MIN BURNUP IN RADIAL DIRECTION

** SYMBOLS AND ABBREVIATIONS **

GRADZ	RATIO OF MAX TO MIN BURNUP IN AXIAL DIRECTION
RB	CLAD OUTER RADIUS
RMF	FUEL OUTER RADIUS
RA	FUEL INNER RADIUS
RGAP	FUEL/CLAD RADIAL GAP
STOICH	FUEL STOICHIOMETRY, PERCENT OF C OR N.
TIME	IRRADIATION TIME, HRS
TEMPS	TEMPERATURES -- MAX,MIN,AVG WITH RESPECT TO TIME
V	FUEL VOLUME
-0	VALUE UNKNOWN

EXPERIMENT FILE SUMMARY

EXP NO.	IDENTIFICATION	FUEL MATL (DENSITY)	CLAD MAT'L (THK,MILS)	RGAP MILS	TIME HRS	TEMP,DEG K FUEL	TEMP,DEG K CLAD	BURNUP O/O	DIAMETER,IN. CLAD	DIAMETER,IN. HOLE	DV/V O/O	DD/D O/O	GAS REL O/O	NOTES (BELOW)
1	BMI CAPS. WR-30	UC(96)	NB-1ZR(20)	0	1080	1541	1400	0.85	0.292	0.	-0.	-0.	76.00	HKO
2	BMI CAPS. WR-31	UC(99)	NB-1ZR(20)	0	1030	1594	1510	1.91	0.165	0.	-0.	-0.	25.00	EHO
3	BMI CAPS. 42-1 PIN 5	UC(96)	NB-1ZR(41)	1	700	1460	1293	0.96	0.291	0.	-0.	0.70	32.00	K E
4	BMI CAPS. 42-1 PIN 6	UC(96)	NB-1ZR(41)	1	700	1357	1220	0.79	0.291	0.	-0.	1.10	0.10	K E
5	BMI CAPS. 42-1 PIN 7	UC(96)	NB-1ZR(40)	1	700	1444	1303	0.80	0.291	0.	-0.	0.70	49.00	K
6	BMI CAPS. 42-1 PIN 13	UC(100)	NB-1ZR(40)	1	700	1447	1303	0.78	0.291	0.	-0.	1.30	16.00	K
7	BMI CAPS. 42-1 PIN 18	UC(100)	NB-1ZR(41)	1	700	1467	1293	0.96	0.291	0.	-0.	1.80	1.80	K E
8	BMI CAPS. 42-1 PIN 19	UC(100)	NB-1ZR(41)	1	700	1377	1220	0.87	0.291	0.	-0.	-0.	9.00	K E
9	BMI CAPS. 42-1 PIN 23	UC(50)	NB-1ZR(40)	1	700	1413	1293	1.30	0.291	0.	-0.	1.20	11.00	K
10	BMI CAPS. 42-1 PIN 24	UC(50)	NB-1ZR(40)	1	700	1394	1293	1.10	0.291	0.	-0.	1.40	17.00	K
11	BMI CAPS. 42-6 PIN 87	UC(100)	W-26RE(20)	1	1050	1597	1463	1.10	0.250	0.	8.10	1.60	1.20	K
12	BMI CAPS. 42-6 PIN 89	UC(100)	NB-1ZR(21)	1	1050	1605	1463	1.20	0.250	0.	9.90	2.30	-0.	E K
13	BMI CAPS. 42-9 PIN 110	UC(100)	W-26RE(20)	1	1400	1570	1488	0.90	0.250	0.	3.85	-0.	0.01	K
14	BMI CAPS. 42-9 PIN 113	UC(100)	W-26RE(21)	1	1400	1549	1469	0.90	0.250	0.	4.75	-0.	0.01	K E
15	BMI CAPS. 42-10 PIN 138	UC(100)	NB-1ZR(21)	1	1750	1245	1188	0.80	0.250	0.	7.30	0.20	0.30	E K H
16	BMI CAPS. 42-10 PIN 140	UC(100)	NB-1ZR(21)	1	1750	1409	1352	0.80	0.250	0.	5.70	0.50	0.10	E K H
17	BMI CAPS. 42-10 PIN 141	UC(100)	NB-1ZR(21)	1	1750	1418	1354	0.90	0.250	0.	-0.	-0.	0.10	E K H
18	BMI CAPS. 42-10 PIN 147	UC(92)	NB-1ZR(21)	1	1750	1481	1415	1.00	0.250	0.	7.60	-0.	3.90	E K H
19	BMI CAPS. 42-10 PIN 148	UC(92)	NB-1ZR(21)	1	1750	1369	1303	1.00	0.250	0.	9.50	0.10	2.70	E K H
20	BMI CAPS. 42-10 PIN 149	UC(92)	NB-1ZR(21)	1	1750	1429	1357	1.10	0.250	0.	8.30	0.30	2.90	E K H
21	BMI CAPS. 42-10 PIN 150	UC(87)	NB-1ZR(21)	1	1750	1462	1400	1.00	0.250	0.	4.60	0.20	6.70	E K H
22	BMI CAPS. 42-10 PIN 152	UC(87)	NB-1ZR(21)	1	1750	1478	1416	1.00	0.250	0.	8.10	0.20	5.20	E K H
23	BMI CAPS. 42-10 PIN 153	UC(87)	NB-1ZR(21)	1	1750	1483	1421	1.00	0.250	0.	1.95	-0.	7.40	E K H
24	BMI CAPS. 42-12 PIN 180	UC(100)	NB-1ZR(21)	1	2100	1535	1393	2.39	0.250	0.	7.80	0.60	2.10	E K
25	BMI CAPS. 42-12 PIN 181	UC(100)	NB-1ZR(21)	1	2100	1655	1513	2.39	0.250	0.	8.30	1.60	4.70	E K
26	BMI CAPS. 42-12 PIN 182	UC(100)	NB-1ZR(21)	1	2100	-0	-0	2.39	0.250	0.	-0.	-0.	-0.	E K
27	BMI CAPS. 42-12 PIN 184	UC(100)	NB-1ZR(41)	1	2100	1588	1503	2.20	0.250	0.	5.60	0.40	0.50	E K
28	BMI CAPS. 42-12 PIN 185	UC(100)	NB-1ZR(41)	1	2100	1678	1593	2.20	0.250	0.	6.10	0.50	2.50	E K
29	BMI CAPS. 42-12 PIN 186	UC(100)	NB-1ZR(41)	1	2100	-0	-0	2.20	0.250	0.	-0.	-0.	-0.	E K
30	BMI CAPS. 42-12 PIN 188	UC(100)	NB-1ZR(61)	1	2100	1567	1523	2.00	0.250	0.	5.90	0.50	0.66	E K
31	BMI CAPS. 42-12 PIN 189	UC(100)	NB-1ZR(61)	1	2100	1597	1553	2.00	0.250	0.	6.20	0.40	-0.	E K
32	BMI CAPS. 42-12 PIN 190	UC(100)	NB-1ZR(61)	1	2100	-0	-0	2.00	0.250	0.	-0.	-0.	-0.	E K
33	BMI CAPS. 42-13 PIN 192	UC(100)	NB-1ZR(21)	1	3850	1330	1213	3.60	0.250	0.	13.00	3.00	-0.	E K
34	BMI CAPS. 42-13 PIN 193	UC(100)	NB-1ZR(21)	1	3850	1360	1243	3.60	0.250	0.	8.80	0.50	-0.	E K
35	BMI CAPS. 42-13 PIN 196	UC(100)	NB-1ZR(21)	1	3850	1260	1143	3.60	0.250	0.	7.40	0.50	-0.	E K
36	BMI CAPS. 42-13 PIN 197	UC(100)	NB-1ZR(21)	1	3850	1260	1143	3.60	0.250	0.	7.60	1.00	-0.	E K
37	BMI CAPS. 42-13 PIN 198	UC(100)	NB-1ZR(21)	1	3850	1410	1293	3.60	0.250	0.	7.40	0.50	-0.	E K
38	BMI CAPS. 42-13 PIN 199	UC(100)	NB-1ZR(21)	1	3850	1340	1223	3.60	0.250	0.	-0.	-0.	-0.	E K
39	BMI CAPS. 42-13 PIN 202	UC(100)	NB-1ZR(21)	1	3850	1420	1303	3.60	0.250	0.	7.40	0.50	-0.	E K
40	BMI CAPS. 42-13 PIN 203	UC(100)	NB-1ZR(21)	1	3850	1350	1233	3.60	0.250	0.	5.80	0.25	-0.	E K

NOTES.....

A=POSSIBLE SIGNIFICANT CAN PRESSURE
B=NITROGEN OVERPRESSURE ON FUEL
C=IMPORTANT TEST DATA MISSING
D=TEMPERATURE EXCURSION OCCURRED
E=LINER BETWEEN FUEL AND CLAD
F=EVIDENCE OF VAPOR TRANSPORT
G=THERMOCOUPLE INSIDE FUEL
H=CHEMICAL REACTION FOUND
I=FUEL/CLAD GAP UNKNOWN
J=CLAD IMMERSED IN NAK
K=HYPERSTOICHIOMETRIC
L=HYPOSTOICHIOMETRIC
M=LITHIUM INSIDE PIN
N=ODD CLAD MATERIAL
O=CLAD FAILURE
P=FUEL PIN VENTED
Q=MODELING REF. CASE
R=FMODEL TEST CASE
S=STILL ON TEST
T=CALCULATION MADE

A ZERO MAY ACTUALLY SIGNIFY AN UNKNOWN VALUE

EXPERIMENT FILE SUMMARY

EXP NO.	IDENTIFICATION	FUEL MATL (DENSITY)	CLAD MAT'L (THK,MILS)	RGAP MILS	TIME HRS	TEMP,DEG K FUEL	CLAD	BURNUP O/O	DIAMETER,IN. CLAD	HOLE	DV/V O/O	DD/D O/O	GAS REL O/O	NOTES (BELOW)
41	BMI CAPS. 42-14 PIN 204	UC(100)	W-26RE(21)	1	2450	1809	1698	2.20	0.250	0.	6.60	1.20	2.20	E K
42	BMI CAPS. 42-14 PIN 205	UC(100)	W-26RE(21)	1	2450	1475	1363	2.20	0.250	0.	10.70	1.60	-0.	E K
43	BMI CAPS. 42-15 PIN 224	UC(100)	W-26RE(20)	1	4900	1559	1453	4.09	0.250	0.	-0.	28.00	-0.	K
44	BMI CAPS. 42-15 PIN 227	UC(100)	W-26RE(20)	1	4900	1603	1473	5.03	0.250	0.	-0.	36.00	-0.	K
45	BMI CAPS. 42-16 PIN 243	UC(100)	W-26RE(20)	1	3500	1624	1498	3.46	0.250	0.	-0.	46.00	-0.	K
46	BMI CAPS. 42-16 PIN 244	UC(100)	W-26RE(20)	1	3500	1610	1473	3.76	0.250	0.	-0.	28.00	-0.	K
47	BMI CAPS. BRR-3 PIN 289	UC(100)	W-26RE(20)	1	3500	1954	1927	0.77	0.250	0.	38.90	16.60	-0.	HTI
48	BMI CAPS. BRR-4 PIN 294	UC(100)	W-26RE(20)	1	3200	1976	1957	0.65	0.250	0.055	34.40	16.50	-0.	HTI O
49	BMI CAPS. BRR-4 PIN 295	UC(100)	W-26RE(20)	1	3200	1908	1889	0.65	0.250	0.055	44.80	17.30	-0.	HTI O
50	BMI CAPS. BRR-4 PIN 296	UC(100)	W-26RE(20)	1	3200	1972	1960	0.88	0.250	0.110	60.20	22.90	-0.	HTI O
51	BMI CAPS. BRR-4 PIN 297	UC(100)	W-26RE(20)	1	3200	1919	1907	0.88	0.250	0.110	60.10	27.50	-0.	HTI O
52	P/W EXP.26-150T PIN 348	UC(94)	NB-1ZR(25)	0	2560	1549	1394	1.15	0.296	0.	5.40	1.15	2.80	AEHIK T
53	P/W EXP.26-150M PIN 349	UC(94)	NB-1ZR(25)	0	2560	1609	1422	1.31	0.296	0.	4.90	1.25	3.30	AEHIKQT
54	P/W EXP.26-150B PIN 350	UC(94)	NB-1ZR(25)	0	2560	1589	1394	1.39	0.296	0.	6.30	1.35	3.60	AEHIK T
55	P/W EXP.26-151M PIN 356	UC(95)	NB-1ZR(25)	0	1020	1703	1463	0.68	0.296	0.	-0.	1.55	7.20	AEHIK T
56	P/W EXP.26-151B PIN 358	UC(95)	NB-1ZR(25)	0	1020	1697	1436	0.72	0.296	0.	-0.	1.30	6.80	AEHIK T
57	P/W EXP.26-153M PIN 368	UC(95)	NB-1ZR(25)	0	670	1669	1477	0.32	0.296	0.	3.90	0.64	2.70	AEHIK T
58	P/W EXP.26-154B PIN 347	UC(95)	NB-1ZR(25)	0	3090	1550	1394	1.40	0.296	0.	16.00	4.20	-0.	AEHIKQT
59	P/W EXP.26-160T PIN 323	UC(96)	NB-1ZR(25)	0	2370	1659	1450	1.45	0.296	0.	9.20	2.70	7.80	AEHIK T
60	P/W EXP.26-160M PIN 327	UC(96)	NB-1ZR(25)	0	2370	1680	1477	1.38	0.296	0.	11.70	3.40	18.80	AEHIK T
61	P/W EXP.26-160B PIN 329	UC(96)	NB-1ZR(25)	0	2370	1672	1463	1.46	0.296	0.	10.10	2.70	10.10	AEHIK T
62	P/W EXP.26-171T PIN 500	UC(97)	NB-1ZR(25)	0	890	1637	1353	0.59	0.296	0.	2.00	0.50	0.10	A HIK T
63	P/W EXP.26-171M PIN 506	UC(97)	NB-1ZR(25)	0	890	1698	1436	0.56	0.296	0.	2.30	0.84	0.20	A HIK T
64	P/W EXP.26-171B PIN 510	UC(97)	NB-1ZR(25)	0	890	1514	1283	0.51	0.296	0.	1.80	-0.	0.10	A HIKQT
65	P/W EXP.26-173M PIN 419	UC(97)	NB-1ZR(25)	0	2280	1746	1491	1.45	0.289	0.	12.40	1.55	9.60	A HIK T
66	P/W EXP.26-173B PIN 424	UC(96)	NB-1ZR(25)	0	2280	1677	1366	1.44	0.289	0.	8.30	2.02	11.90	A HIK T
67	P/W EXP.26-174M PIN 420	UC(97)	NB-1ZR(25)	0	2600	1720	1477	1.58	0.289	0.	17.80	7.28	55.40	A HIK T
68	P/W EXP.26-174B PIN 426	UC(96)	NB-1ZR(25)	0	2600	1736	1463	1.83	0.289	0.	14.20	2.18	10.10	A HIK T
69	P/W EXP.26-190T PIN 405	UC(93)	NB-1ZR(25)	0	1060	1575	1339	0.66	0.296	0.	-0.	0.40	58.20	AEHI T
70	P/W EXP.26-190M PIN 410	UC(92)	NB-1ZR(25)	0	1060	1650	1394	0.70	0.296	0.	-0.	0.30	73.40	AEHI QT
71	P/W EXP.26-190B PIN 409	UC(93)	NB-1ZR(25)	0	1060	1593	1353	0.64	0.296	0.	-0.	0.10	59.30	AEHI T
72	P/W EXP.26-191T PIN 412	UC(94)	NB-1ZR(25)	0	1570	1517	1366	0.86	0.296	0.	-0.	-0.	37.20	AEHI T
73	P/W EXP.26-191M PIN 402	UC(92)	NB-1ZR(25)	0	1570	1627	1450	1.01	0.296	0.	-0.	0.64	37.50	AEHI T
74	P/W EXP.26-191B PIN 411	UC(94)	NB-1ZR(25)	0	1570	1582	1422	0.91	0.296	0.	-0.	0.64	29.00	AEHI T
75	GGA BRR-8 PIN 90-21	U10ZRC(80)	CVDW(20)	0	3000	2007	1989	0.91	0.250	0.065	12.00	-1.00	70.00	ITP Q
76	GGA BRR-8 PIN 90-22	U10ZRC(75)	W-26RE(20)	0	3000	1876	1858	0.97	0.250	0.065	21.00	13.50	-0.	H I P
77	PBRF 62-13 V-2C	U10ZRC(77)	FCVDW(40)	1	11090	1980	1930	1.50	0.625	0.187	39.00	2.80	66.00	GHKOP
78	PBRF 62-13 V-2D	U50ZRC(78)	FCVDW(40)	1	12030	1925	1925	1.70	0.625	0.187	56.00	03.30	85.00	GHKOP
79	PBRF 70-06 V2-E	U10ZRC(77)	CVDW(63)	2	6000	1849	1820	0.60	0.632	0.187	-0.	-0.	-0.	G P S
80	GGA MK VI IC-13 (IC-16)	U10ZRC(0)	FCVDW(50)	6	7343	1878	1878	1.20	0.646	0.151	10.00	6.00	65.00	G H K P

NOTES.....

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EXP NO.	IDENTIFICATION	FUEL MATL (DENSITY)	CLAD MAT'L (THK,MILS)	RGAP MILS	TIME HRS	TEMP,DEG K FUEL	CLAD	BURNUP O/O	DIAMETER,IN. CLAD	HOLE	DV/V O/O	DD/D O/O	GAS REL O/O	NOTES (BELOW)
81	GGA MK VI IC-I5	U10ZRC(70)	DCVDW(50)	1	3791	1947	1907	0.36	0.646	0.119	-0.	0.30	40.00	H P
82	GGA MK VIIA IC-B2	U10ZRC(0)	FCVDW(0)	0	4543	-0	-0	0.61	0.	0.	-0.	-0.	-0.	
83	GGA MK VIIB IC-C3	U10ZRC(75)	FCVDW(40)	6	5445	2044	1975	0.22	1.101	0.156	-0.	0.88	-0.	H K P
84	GGA MK VIIB IC-C11	U10ZRC(75)	FCVDW(40)	5	7881	1897	1843	0.32	1.104	0.313	-0.	0.73	-0.	A H
85	GGA 2E3 CELL 1	U10ZRC(76)	DCVDW(50)	3	3661	1712	1670	0.35	0.629	0.104	-0.	-0.	-0.	
86	GGA 2E3 CELL 2	U10ZRC(76)	DCVDW(50)	3	3661	1712	1670	0.35	0.629	0.104	-0.	-0.	-0.	
87	GGA 1F2	UC+4W(81)	DCVDW(40)	5	6378	1934	1870	0.26	1.099	0.312	-0.	-0.	-0.	K P
88	GGA 1F3	UC+4W(78)	DCVDW(40)	5	3378	1923	1860	0.14	1.099	0.312	-0.	-0.	-0.	K P
89	GGA 1F4	U10ZRC(78)	DCVDW(40)	4	3038	1900	1900	-0.	1.099	0.306	-0.	-0.	-0.	S
90	GGA 2F1 CELL 1	U10ZRC(74)	DCVDW(80)	5	7510	1850	1850	-0.	1.099	0.279	-0.	-0.	-0.	K P S
91	GGA 2F1 CELL 2	U10ZRC(79)	DCVDW(80)	5	7510	1860	1860	-0.	1.099	0.279	-0.	-0.	-0.	K P S
92	GGA 2F2 CELL 1	U10ZRC(79)	DCVDW(40)	5	3684	1830	1830	-0.	1.099	0.306	-0.	-0.	-0.	K P S
93	GGA 2F2 CELL 2	U10ZRC(80)	DCVDW(40)	5	3684	1830	1830	-0.	1.099	0.306	-0.	-0.	-0.	K P S
94	GGA 6F1 CELL 1	U10ZRC(76)	DCVDW(40)	5	6378	1998	1940	0.21	1.099	0.147	-0.	0.20	-0.	K P
95	GGA 6F1 CELL 2	U10ZRC(76)	DCVDW(40)	5	6378	1998	1940	0.21	1.099	0.147	-0.	0.40	-0.	K P
96	GGA 6F1 CELL 3	U10ZRC(76)	DCVDW(40)	5	6378	1997	1940	0.21	1.099	0.147	-0.	0.40	-0.	K P
97	GGA 6F1 CELL 4	U10ZRC(79)	DCVDW(40)	5	6378	2000	1940	0.21	1.099	0.147	-0.	1.30	-0.	K P
98	GGA 6F1 CELL 5	U10ZRC(77)	DCVDW(40)	5	6378	1998	1940	0.21	1.099	0.147	-0.	1.20	-0.	K P
99	GGA 6F1 CELL 6	U10ZRC(80)	DCVDW(40)	5	6378	2000	1940	0.21	1.099	0.147	-0.	1.80	-0.	K P
100	GGA 6F2 CELL 1	U10ZRC(86)	DCVDW(40)	5	7685	1961	1920	0.21	1.099	0.312	-0.	-0.	-0.	K P
101	GGA 6F2 CELL 2	U10ZRC(77)	DCVDW(40)	5	7685	1937	1900	0.21	1.099	0.312	-0.	-0.	-0.	K P
102	GGA 6F2 CELL 3	U10ZRC(76)	DCVDW(40)	5	7685	1936	1900	0.21	1.099	0.312	-0.	-0.	-0.	K P
103	GGA 6F2 CELL 4	U10ZRC(76)	DCVDW(40)	5	7685	1896	1860	0.21	1.099	0.312	-0.	-0.	-0.	K P
104	GGA 6F2 CELL 5	U10ZRC(76)	DCVDW(40)	5	7685	1866	1830	0.21	1.099	0.312	-0.	-0.	-0.	K P
105	GGA 6F2 CELL 6	U10ZRC(79)	DCVDW(40)	5	7685	1947	1910	0.21	1.099	0.312	-0.	-0.	-0.	K P
106	GGA 6F4 CELL 1	U10ZRC(81)	DCVDW(80)	5	1066	1660	1660	-0.	1.099	0.279	-0.	-0.	-0.	S
107	GGA 6F4 CELL 2	U10ZRC(86)	DCVDW(80)	5	1066	1690	1690	-0.	1.099	0.279	-0.	-0.	-0.	S
108	GGA 6F4 CELL 3	U10ZRC(84)	DCVDW(80)	5	1066	1740	1740	-0.	1.099	0.279	-0.	-0.	-0.	S
109	GGA 6F4 CELL 4	U10ZRC(82)	DCVDW(80)	5	1066	1730	1730	-0.	1.099	0.279	-0.	-0.	-0.	S
110	GGA 6F4 CELL 5	U10ZRC(81)	DCVDW(80)	5	1066	1710	1710	-0.	1.099	0.279	-0.	-0.	-0.	S
111	GGA 6F4 CELL 6	U10ZRC(81)	DCVDW(80)	5	1066	1670	1670	-0.	1.099	0.279	-0.	-0.	-0.	S
112	PW26-200 SPEC. 42	UN(90)	NB-1ZR(35)	2	390	1144	1103	0.06	0.314	0.	-0.	-0.	0.08	
113	PW26-200 SPEC. 43	UN(91)	NB-1ZR(35)	2	390	1248	1214	0.06	0.314	0.	-0.	-0.	0.09	
114	PW26-200 SPEC. 44	UN(91)	NB-1ZR(35)	2	390	1158	1117	0.05	0.314	0.	-0.	-0.	-0.	C
115	PW26-201 SPEC. 39	UN(90)	NB-1ZR(35)	2	1590	1325	1242	0.54	0.314	0.	-0.	-0.	-0.	C
116	PW26-201 SPEC. 40	UN(91)	NB-1ZR(35)	2	1590	1443	1353	0.57	0.314	0.	-0.	-0.	3.50	
117	PW26-201 SPEC. 41	UN(90)	NB-1ZR(35)	2	1590	1422	1311	0.72	0.314	0.	-0.	-0.	5.10	
118	PW26-210 SPEC. 108	UN(96)	NB-1ZR(35)	2	1090	1477	1380	0.42	0.309	0.	-0.	-0.	3.00	
119	PW26-210 SPEC. 109	UN(96)	NB-1ZR(35)	2	1090	1533	1436	0.42	0.309	0.	-0.	-0.	3.30	
120	PW26-210 SPEC. 110	UN(96)	NB-1ZR(35)	2	1090	1533	1436	0.40	0.309	0.	-0.	-0.	2.50	

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121	PW26-220 SPEC. 118	UN(94)	NB-1ZR(35)	2	1690	1429	1297	1.20	0.309	0.	5.00	0.47	4.80	
122	PW26-220 SPEC. 119	UN(94)	NB-1ZR(35)	2	1690	1582	1450	1.20	0.309	0.	6.00	0.78	11.70	
123	PW26-220 SPEC. 121	UN(94)	NB-1ZR(35)	2	1690	1443	1297	1.21	0.309	0.	1.90	0.37	4.20	
124	PW26-230 SPEC. 123	UN(96)	NB-1ZR(36)	2	850	1568	1408	0.58	0.312	0.	1.50	-0.	0.53	E
125	PW26-230 SPEC. 124	UN(96)	NB-1ZR(36)	2	850	1658	1492	0.63	0.312	0.	2.60	-0.	0.88	E Q
126	PW26-230 SPEC. 125	UN(96)	NB-1ZR(36)	2	850	1547	1380	0.61	0.312	0.	0.90	-0.	0.68	E
127	PW26-231 SPEC. 126	UN(96)	NB-1ZR(36)	2	2750	1533	1353	2.26	0.312	0.	8.90	0.77	9.90	E
128	PW26-231 SPEC. 127	UN(96)	NB-1ZR(36)	2	2750	1665	1492	2.23	0.312	0.	10.00	1.54	29.10	E
129	PW26-231 SPEC. 128	UN(96)	NB-1ZR(36)	2	2750	1581	1394	2.34	0.312	0.	8.40	0.93	11.10	E
130	PW26-240 SPEC. 132	UN(95)	NB-1ZR(26)	2	3000	1554	1408	1.65	0.296	0.	5.80	1.20	17.20	E
131	PW26-240 SPEC. 133	UN(95)	NB-1ZR(26)	2	3000	1637	1478	1.82	0.296	0.	8.00	2.00	32.30	E Q
132	PW26-240 SPEC. 134	UN(94)	NB-1ZR(26)	2	3000	1568	1436	1.51	0.296	0.	7.80	1.00	21.90	E
133	PW26-241 SPEC. 135	UN(95)	NB-1ZR(26)	2	1100	1616	1436	0.78	0.296	0.	4.90	0.20	5.80	E
134	PW26-241 SPEC. 136	UN(95)	NB-1ZR(26)	2	1100	1665	1492	0.74	0.296	0.	2.50	0.37	3.90	E
135	PW26-241 SPEC. 137	UN(94)	NB-1ZR(26)	2	1100	1588	1422	0.72	0.296	0.	4.90	-0.	4.00	E
136	PW CAPSULE 600 TOP PIN	UN(98)	NB-1ZR(30)	2	662	1348	1313	0.19	0.250	0.	3.00	0.08	0.10	E
137	PW CAPSULE 600 MID PIN	UN(96)	NB-1ZR(30)	2	662	1470	1438	0.18	0.250	0.	1.80	0.20	0.10	E
138	PW CAPSULE 600 BOT PIN	UN(96)	NB-1ZR(30)	2	662	1483	1448	0.18	0.250	0.	1.80	0.36	0.10	E
139	PW CAPSULE 601 TOP PIN	UN(97)	NB-1ZR(30)	2	1372	1403	1368	0.39	0.250	0.	3.50	-0.	0.10	E
140	PW CAPSULE 601 MID PIN	UN(96)	NB-1ZR(30)	2	1372	1470	1438	0.39	0.250	0.	2.70	-0.	0.20	E
141	PW CAPSULE 601 BOT PIN	UN(96)	NB-1ZR(30)	2	1372	1458	1423	0.40	0.250	0.	2.10	-0.	0.20	E
142	PW CAPSULE 603 TOP PIN	UN(96)	NB-1ZR(30)	2	3310	1265	1218	0.78	0.250	0.	2.90	0.56	0.05	E
143	PW CAPSULE 603 MID PIN	UN(96)	NB-1ZR(30)	2	3310	1408	1368	0.76	0.250	0.	2.70	0.24	0.10	E
144	PW CAPSULE 603 BOT PIN	UN(96)	NB-1ZR(30)	2	3310	1388	1338	0.78	0.250	0.	2.10	0.36	0.06	E
145	PW CAPSULE 610 TOP PIN	UN(97)	NB-1ZR(30)	2	384	-0	-0	-0.	0.250	0.	-0.	-0.	-0.	C E
146	PW CAPSULE 610 MID PIN	UN(96)	NB-1ZR(30)	2	384	-0	-0	-0.	0.250	0.	-0.	-0.	-0.	C E
147	PW CAPSULE 610 BOT PIN	UN(96)	NB-1ZR(30)	2	384	-0	-0	-0.	0.250	0.	-0.	-0.	-0.	C E
148	PW26-602 SPEC. W-17	UN-HI(95)	NB-1ZR(28)	2	5940	1241	1214	0.97	0.250	0.	3.00	0.12	0.02	
149	PW26-602 SPEC. W-18	UN-HI(96)	NB-1ZR(28)	2	5940	1394	1367	0.91	0.250	0.	3.50	0.24	0.20	
150	PW26-602 SPEC. W-19	UN-HI(95)	NB-1ZR(28)	2	5940	1366	1339	0.86	0.250	0.	2.40	0.20	0.08	
151	PW26-613 SPEC. W-47	UN-HI(96)	NB-1ZR(31)	2	1970	1338	1283	0.54	0.252	0.	1.00	0.08	0.04	
152	PW26-613 SPEC. W-44	UN-HI(96)	NB-1ZR(31)	2	1970	1450	1394	0.53	0.252	0.	1.40	-0.	0.06	
153	PW26-613 SPEC. W-46	UN-HI(96)	NB-1ZR(31)	2	1970	1352	1297	0.58	0.252	0.	1.70	0.40	0.03	
154	PW26-640 SPEC. WL-25	UN-HI(94)	PWC-11(30)	1	2540	1505	1478	0.42	0.250	0.051	1.20	-0.	0.04	
155	PW26-630 SPEC. WL-2	UN-HI(95)	PWC-11(30)	1	810	1568	1492	0.25	0.250	0.051	1.05	-0.	0.06	
156	PW26-631 SPEC. WL-23	UN-HI(95)	PWC-11(30)	-92	3360	1554	1478	1.42	0.250	0.051	6.00	0.36	-0.	
157	PW26-632 SPEC. WL-3	UN-HI(96)	PWC-11(31)	-90	3370	1478	1478	-0.	0.250	0.051	8.43	-0.	-0.	
158	PW26-633 SPEC. WL-1	UN-HI(95)	PWC-11(30)	1	3360	1561	1478	1.47	0.250	0.	8.84	-0.	-0.	
159	PW26-635 SPEC. WL-4	UN-HI(96)	PWC-11(31)	-90	3300	1478	1478	-0.	0.250	0.	9.63	-0.	-0.	
160	LRL-1 PIN 1-C	UN(96)	W-26RE(20)	1	3558	1561	1543	0.69	0.242	0.010	4.80	0.83	-0.	B G O P

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161	LRL-1 PIN 2-A	UN(100)	W-26RE(20)	1	3558	1632	1614	0.67	0.241	0.010	3.50	0.83	-0.	B O P
162	LRL-1 PIN 3B	UN(100)	W-26RE(20)	0	3558	1652	1634	0.67	0.241	0.010	2.70	0.83	-0.	B O P
163	LRL-1 PIN 4D	UN(78)	W-26RE(20)	1	3558	1612	1594	0.85	0.242	0.010	3.60	0.83	-0.	B O P
164	LRL-1 PIN 5E	UN(78)	W-26RE(20)	1	3558	1632	1614	0.85	0.242	0.010	4.60	0.83	-0.	B O P
165	LRL-1 PIN 6G	UN(96)	W-26RE(20)	0	3558	1672	1654	0.69	0.241	0.010	12.00	2.50	-0.	B O P
166	LRL-1 PIN 7H	UN(97)	W-26RE(20)	0	3558	1622	1604	0.69	0.241	0.010	5.40	1.24	-0.	B O P
167	LRL-1 PIN 8I	UN(97)	W-26RE(20)	0	3558	1642	1624	0.69	0.240	0.010	5.20	1.24	-0.	B O P
168	LRL-2 PIN N	UN(98)	W-26RE(20)	0	3460	1884	1876	0.63	0.240	0.100	3.40	0.60	-0.	BTP
169	LRL-2 PIN P	UN(98)	W-26RE(20)	0	3460	1551	1543	0.63	0.240	0.100	2.80	0.40	-0.	BTG P
170	LRL-2 PIN O	UN(100)	W-26RE(20)	0	3460	1705	1697	0.63	0.240	0.100	1.80	-0.	-0.	BTG P
171	LRL-2 PIN O	UN(100)	W-26RE(20)	0	3460	1705	1697	0.63	0.240	0.100	1.80	-0.	-0.	BTG P
172	LRL-2 PIN L	UN(100)	W-26RE(20)	0	3460	1806	1798	0.63	0.240	0.100	0.60	-0.	-0.	BTP
173	LRL-2 PIN L	UN(100)	W-26RE(20)	0	3460	1806	1798	0.63	0.240	0.100	0.60	-0.	-0.	BTP
174	LRL-2 PIN J	UN(98)	W-26RE(20)	0	3460	1732	1724	0.63	0.240	0.100	1.40	-0.	-0.	BTG P
175	BMI HT-BRR-8 PIN 336	UN(92)	W-26RE(20)	6	3000	1944	1925	0.60	0.250	0.	76.80	43.70	70.00	F O
176	BMI HT-BRR-8 PIN 337	UN(92)	W-26RE(20)	6	3000	1869	1850	0.60	0.250	0.	33.40	21.40	70.00	F O
177	BMI HT-BRR-8 PIN 330	UN(85)	W-26RE(20)	0	3000	2063	2044	0.60	0.250	0.	23.40	11.50	70.00	F O
178	BMI HT-BRR-8 PIN 331	UN(85)	W-26RE(20)	0	3000	2079	2060	0.60	0.250	0.	18.20	8.70	70.00	F
179	BMI HT-BRR-7 PIN 322	UN(70)	W-26RE(20)	0	3500	1944	1928	0.71	0.250	0.	5.00	2.20	-0.	F
180	BMI HT-BRR-7 PIN 323	UN(70)	W-26RE(20)	0	3500	1940	1924	0.69	0.250	0.	7.20	4.90	-0.	F
181	BMI HT-BRR-6 PIN 314B	UN(98)	WALLOY(40)	0	2600	1881	1865	0.49	0.290	0.055	7.90	9.50	-0.	F N
182	BMI HT-BRR-6 PIN 315B	UN(98)	WALLOY(40)	0	2600	1928	1912	0.49	0.290	0.055	5.80	2.40	-0.	F N
183	BMI HT-BRR-6 PIN 316	UN(98)	W-26RE(40)	0	2600	1917	1901	0.51	0.290	0.055	14.90	9.00	-0.	
184	BMI HT-BRR-6 PIN 317	UN(98)	W-26RE(40)	0	2600	1968	1952	0.50	0.290	0.055	20.50	11.10	-0.	D
185	BMI HT-BRR-10 PIN 348	UN(80)	W-26RE(20)	0	3000	1993	1972	0.76	0.250	0.	33.20	16.80	39.00	K
186	BMI HT-BRR-10 PIN 351	UN(99)	W-26RE(20)	0	3000	1901	1881	0.58	0.250	0.	12.90	8.30	-0.	K D
187	BMI HT-BRR-10 PIN 352	UN(99)	W-26RE(20)	0	3000	1901	1881	0.58	0.250	0.	12.50	7.40	-0.	K D
188	BMI HT-BRR-10 PIN 350	UN(100)	W-26RE(20)	0	3000	1940	1917	0.66	0.250	0.	6.80	3.20	-0.	K
189	BMI HT-BRR-10 PIN 353	UN(99)	W-26RE(20)	0	3000	1826	1807	0.55	0.250	0.	9.00	4.70	-0.	K O
190	ORNL PIN LN-1T	UN(0)	D-43(30)	0	5397	1355	1303	2.00	0.250	0.	5.30	0.20	-0.	CTI N
191	ORNL PIN LN-1B	UN(0)	D-43(30)	0	5397	1440	1388	2.00	0.250	0.	14.00	5.00	-0.	CTI N
192	ORNL PIN LN-2T	UN(0)	T-111(30)	0	8056	1460	1408	1.60	0.250	0.	9.90	0.70	-0.	C I N
193	ORNL PIN LN-2B	UN(0)	T-111(30)	0	8056	1710	1658	1.60	0.250	0.	-0.	1.60	-0.	C I N
194	ORNL PIN LN-3T	UN(0)	T-111(30)	0	7045	1315	1263	2.77	0.250	0.	5.60	0.20	-0.	CTI N
195	ORNL PIN LN-3B	UN(0)	T-111(30)	0	7045	1630	1578	2.77	0.250	0.	8.90	0.80	-0.	CTI N
196	ORNL PIN LN-4T	UN(0)	T-111(30)	0	4540	1440	1388	2.10	0.250	0.	5.90	2.00	-0.	C I N
197	ORNL PIN LN-4B	UN(0)	T-111(30)	0	4540	1640	1588	2.10	0.250	0.	7.50	4.00	-0.	C I N
198	ORNL PIN LN-5	UN(0)	D-43(30)	0	1310	1545	1503	1.30	0.250	0.	5.90	1.20	-0.	CTI N G
199	ORNL PIN LN-6T	UN(0)	D-43(30)	0	5520	1460	1408	1.79	0.250	0.	6.40	1.00	-0.	CTI N
200	ORNL PIN LN-6B	UN(0)	D-43(30)	0	5520	1650	1598	1.79	0.250	0.	14.70	4.30	-0.	CTI N

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201	ORNL 57-612 TOP PIN	UN-HI(0)	PWC-11(30)	1	5205	1240	1143	2.54	0.250	0.	5.00	0.84	0.05	E
202	ORNL 57-612 MID PIN	UN-HI(0)	PWC-11(30)	1	5205	1350	1248	2.54	0.250	0.	5.00	1.25	0.37	E
203	ORNL 57-612 BOT PIN	UN-HI(94)	PWC-11(30)	1	5205	1285	1188	2.54	0.250	0.	5.00	0.92	0.09	E Q
204	ORNL 57-642	UN-HI(0)	PWC-11(30)	1	9966	1475	1453	1.18	0.250	0.	4.10	0.80	0.34	E
205	ORNL 57-643	UN-HI(0)	PWC-11(30)	1	4292	1493	1453	0.85	0.250	0.	3.30	0.36	-0.	C E
206	ORNL 57-649	UN-HI(0)	PWC-11(30)	1	10512	1460	1433	1.43	0.250	0.	2.74	0.59	0.04	E
207	ORNL 57-652 TOP PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.70	0.250	0.	-0.	-0.	-0.	C E
208	ORNL 57-652 MID PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.70	0.250	0.	-0.	0.16	0.09	E
209	ORNL 57-652 BOT PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.70	0.250	0.	-0.	0.20	-0.	C E
210	ORNL 57-656 TOP PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.60	0.250	0.	-0.	0.24	0.03	E
211	ORNL 57-656 MID PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.60	0.250	0.	-0.	0.12	0.11	E
212	ORNL 57-656 BOT PIN	UN-HI(0)	PWC-11(30)	1	3180	-0	-0	0.60	0.250	0.	-0.	0.48	0.13	E
213	ORNL 57-658 TOP PIN	UN-HI(0)	PWC-11(30)	1	9779	1408	1388	1.08	0.250	0.	3.80	-0.	-0.	C E
214	ORNL 57-658 MID PIN	UN-HI(0)	PWC-11(30)	1	9779	1480	1458	1.08	0.250	0.	4.00	0.18	0.14	E
215	ORNL 57-658 BOT PIN	UN-HI(0)	PWC-11(30)	1	9779	1460	1438	1.08	0.250	0.	3.60	0.16	0.09	C E
216	ORNL 57-660 TOP PIN	UN-HI(0)	PWC-11(30)	1	2635	-0	-0	0.70	0.250	0.	-0.	0.28	-0.	C E
217	ORNL 57-660 MID PIN	UN-HI(0)	PWC-11(30)	1	2635	-0	-0	0.70	0.250	0.	-0.	0.28	0.05	E
218	ORNL 57-660 BOT PIN	UN-HI(0)	PWC-11(30)	1	2635	-0	-0	0.70	0.250	0.	-0.	0.20	-0.	C E
219	ORNL 57-662 TOP PIN	UN-HI(0)	PWC-11(30)	1	10270	1363	1338	1.16	0.250	0.	4.30	0.47	0.01	E
220	ORNL 57-662 MID PIN	UN-HI(0)	PWC-11(30)	1	10270	1498	1473	1.16	0.250	0.	4.50	0.43	0.08	E
221	ORNL 57-662 BOT PIN	UN-HI(0)	PWC-11(30)	1	10270	1488	1463	1.16	0.250	0.	4.70	0.40	0.04	E
222	ORNL 57-664 TOP PIN	UN-HI(0)	PWC-11(30)	1	6209	1400	1383	0.58	0.250	0.	1.80	0.12	-0.	C E
223	ORNL 57-664 MID PIN	UN-HI(0)	PWC-11(30)	1	6209	1443	1423	0.58	0.250	0.	1.50	-0.08	-0.	C E
224	ORNL 57-664 BOT PIN	UN-HI(0)	PWC-11(30)	1	6209	1458	1438	0.58	0.250	0.	1.20	0.08	-0.	C E
225	ORNL 57-665 TOP PIN	UN-HI(0)	PWC-11(30)	1	9583	1228	1133	4.58	0.250	0.	7.70	1.00	1.36	E
226	ORNL 57-665 MID PIN	UN-HI(0)	PWC-11(30)	1	9583	1332	1238	4.58	0.250	0.	8.50	1.52	5.96	E Q
227	ORNL 57-665 BOT PIN	UN-HI(0)	PWC-11(30)	1	9583	1275	1178	4.58	0.250	0.	8.30	1.07	1.78	E T
228	ORNL 57-667 TOP PIN	UN-HI(0)	PWC-11(30)	1	6209	1413	1388	0.78	0.250	0.	3.10	-0.	-0.	C E
229	ORNL 57-667 MID PIN	UN-HI(0)	PWC-11(30)	1	6209	1473	1448	0.78	0.250	0.	1.80	0.12	0.02	E
230	ORNL 57-667 BOT PIN	UN-HI(0)	PWC-11(30)	1	6209	1478	1453	0.78	0.250	0.	1.90	0.16	0.03	E
231	ORNL 57-669 TOP PIN	UN-HI(0)	PWC-11(30)	1	10352	1160	1108	2.72	0.250	0.	6.50	0.52	0.05	E
232	ORNL 57-669 MID PIN	UN-HI(0)	PWC-11(30)	1	10352	1300	1253	2.72	0.250	0.	7.40	0.36	0.13	E T
233	ORNL 57-669 BOT PIN	UN-HI(0)	PWC-11(30)	1	10352	1255	1203	2.72	0.250	0.	6.00	0.36	0.02	E
234	ORNL 57-0C2 TOP PIN	UN-HI(0)	PWC-11(30)	1	10173	1420	1398	1.12	0.250	0.	2.50	0.39	-0.	C E
235	ORNL 57-0C2 2ND FROM TOP	UN-HI(0)	PWC-11(30)	1	10173	1480	1458	1.12	0.250	0.	2.30	0.55	-0.	C E
236	ORNL 57-0C2 3RD FROM TOP	UN-HI(0)	PWC-11(30)	1	10173	1497	1476	1.12	0.250	0.	2.00	0.71	0.06	C E
237	ORNL 57-0C2 BOT PIN	UN-HI(0)	PWC-11(30)	1	10173	1458	1438	1.12	0.250	0.	-0.	0.75	-0.	E
238	ORNL 57-0C3 TOP PIN	UN-HI(0)	PWC-11(30)	1	11985	1443	1373	4.17	0.250	0.	10.70	1.42	6.00	E T
239	ORNL 57-0C3 2ND FROM TOP	UN-HI(0)	PWC-11(30)	1	11985	1503	1433	4.17	0.250	0.	10.40	1.90	10.30	E
240	ORNL 57-0C3 3RD FROM TOP	UN-HI(0)	PWC-11(30)	1	11985	1528	1458	4.17	0.250	0.	10.20	2.02	11.50	E

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241	ORNL 57-0C3 BOT PIN	UN-HI(0)	PWC-11(30)	1	11985	1503	1433	4.17	0.250	0.	12.10	1.90	12.60	E Q
242	ORNL UN-1 TOP PIN	UN(94)	W-26RE(30)	2	8250	1393	1313	1.78	0.365	0.105	5.45	0.08	0.14	G J Q
243	ORNL UN-1 MIDDLE PIN	UN(0)	W-26RE(30)	27	8250	1448	1373	-0.	0.365	0.	7.23	0.38	-0.	C G J
244	ORNL UN-1 BOTTOM PIN	UN(95)	W-26RE(30)	2	8250	1573	1473	1.83	0.365	0.	5.40	0.25	-0.	G J
245	ORNL UN-2 TOP PIN	UN(94)	W-26RE(30)	2	220	2095	1818	0.05	0.365	0.105	-0.	-0.98	63.50	D G J
246	ORNL UN-2 MIDDLE PIN	UN(0)	W-26RE(30)	27	330	1523	1448	0.05	0.365	0.	-0.	-0.	8.30	D G J
247	ORNL UN-2 BOTTOM PIN	UN(95)	W-26RE(30)	2	330	1723	1623	0.05	0.365	0.	-0.	0.08	0.01	D G J
248	ORNL UN-3 TOP PIN	UN(94)	W-26RE(30)	2	5807	1598	1573	1.45	0.365	0.105	3.90	-0.27	0.10	G J
249	ORNL UN-3 MIDDLE PIN	UN(96)	T-111(30)	2	5807	1723	1673	1.75	0.365	0.	4.90	0.19	-0.	G J O Q
250	ORNL UN-3 BOTTOM PIN	UN(96)	T-111(30)	1	5807	1735	1673	1.75	0.362	0.	2.60	-0.01	7.10	J T
251	ORNL UN4 TOP PIN	UN-LO(86)	T-111(30)	2	10450	1304	1246	2.88	0.372	0.	-0.	0.13	-0.	CE
252	ORNL UN4 MIDDLE PIN	UN-LO(84)	T-111(30)	2	10450	1301	1245	2.84	0.372	0.	-0.	0.27	-0.	CE
253	ORNL UN4 BOTTOM PIN	UN-LO(94)	T-111(30)	2	10450	1246	1202	2.80	0.373	0.090	-0.	1.50	-0.	CEOT
254	ORNL UN5 TOP PIN	UN-LO(86)	T-111(32)	2	10037	1337	1279	2.77	0.375	0.	-0.	0.19	-0.	CE
255	ORNL UN5 MIDDLE PIN	UN-LO(94)	T-111(31)	2	10037	1305	1263	2.64	0.373	0.090	-0.	2.96	-0.	CEOT
256	ORNL UN5 BOTTOM PIN	UN-LO(84)	T-111(30)	2	10037	1303	1247	2.73	0.373	0.	-0.	0.37	-0.	CE
257	PBRF 69-01 PIN 001-504B	UN-HI(94)	T-111(46)	2	8070	1308	1250	0.47	0.717	0.201	-0.	-0.16	0.02	E G
258	PBRF 69-01 PIN 001-503B	UN-HI(95)	T-111(24)	2	8070	1223	1190	0.89	0.361	0.112	2.16	-0.09	0.05	E G
259	PBRF 69-01 PIN 001-503C	UN-HI(95)	T-111(24)	2	8070	1220	1187	0.90	0.361	0.112	1.30	-0.25	0.10	E G
260	PBRF 69-01 PIN 002-502A	UN(100)	T-111(63)	2	6925	1308	1255	0.37	0.750	0.	-0.	-0.	-0.	C
261	PBRF 69-01 PIN 002-501A	UN(100)	T-111(33)	2	6925	1281	1255	0.75	0.375	0.	-0.	-0.	-0.	C
262	PBRF 69-01 PIN 002-501B	UN(100)	T-111(33)	2	6925	1281	1255	0.75	0.375	0.	-0.	-0.	-0.	C
263	PBRF 69-01 PIN 003-504E	UN(100)	T-111(46)	2	12930	1308	1255	0.70	0.715	0.	-0.	-0.07	-0.	E G
264	PBRF 69-01 PIN 003-503D	UN(100)	T-111(24)	2	12930	1281	1255	1.40	0.358	0.	-0.	-0.	-0.	C
265	PBRF 69-01 PIN 003-503E	UN(100)	T-111(24)	2	12930	1281	1255	1.40	0.358	0.	-0.	-0.04	-0.	E G
266	PBRF 69-01 PIN 004-502B	UN-HI(93)	T-111(64)	2	883	1291	1229	0.05	0.754	0.202	-0.	-0.	-0.	E G
267	PBRF 69-01 PIN 004-501D	UN(100)	T-111(33)	2	12090	1281	1255	1.31	0.375	0.	-0.	-0.	-0.	CCCCCCCC
268	PBRF 69-01 PIN 004-501F	UN(100)	T-111(33)	2	12090	1281	1255	1.31	0.375	0.	-0.	-0.	-0.	CCCCCCCC
269	PBRF 69-01 PIN 005-502C	UN-HI(94)	T-111(63)	2	9386	1306	1250	0.54	0.754	0.202	1.50	0.10	-0.	E G H O
270	PBRF 69-01 PIN 005-501C	UN(100)	T-111(33)	2	11630	1281	1255	1.26	0.375	0.	-0.	-0.	-0.	CCCCCCCC
271	PBRF 69-01 PIN 005-501E	UN(100)	T-111(33)	2	11630	1281	1255	1.26	0.375	0.	-0.	-0.	-0.	CCCCCCCC
272	PBRF 69-01 PIN 006-504D	UN(100)	T-111(46)	2	6650	1308	1255	0.36	0.715	0.	-0.	-0.	-0.	C
273	PBRF 69-01 PIN 006-503F	UN(100)	T-111(24)	2	6650	1281	1255	0.72	0.358	0.	-0.	-0.	-0.	C
274	PBRF 69-01 PIN 006-503H	UN(100)	T-111(24)	2	6650	1281	1255	0.72	0.358	0.	-0.	-0.	-0.	C
275	PBRF 69-01 PIN 010-503G	UN-LO(94)	T-111(24)	2	8750	1287	1228	1.89	0.361	0.110	-0.	0.18	-0.	E G O T
276	PBRF 69-01 PIN 010-503I	UN-HI(95)	T-111(23)	2	8163	1263	1204	1.71	0.360	0.112	-0.	1.35	-0.	E G O
277	PBRF 69-01 PIN 011-505E	UN(100)	T-111(24)	2	7093	1307	1255	1.53	0.358	0.	-0.	0.97	2.50	E G
278	PBRF 69-01 PIN 011-505F	UN(100)	T-111(24)	2	7093	1307	1255	1.53	0.358	0.	-0.	-0.	0.28	E G
279	PBRF 69-01 PIN 012-507C	UN(100)	T-111(31)	2	7323	1308	1255	1.58	0.375	0.	-0.	-0.	-0.	C
280	PBRF 69-01 PIN 012-507D	UN(100)	T-111(31)	2	7323	1308	1255	1.58	0.375	0.	-0.	-0.	-0.	C

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281	PBRF 69-01 PIN 013-509A	UN(100)	T-111(24)	2	7100	1307	1255	1.53	0.358	0.	-0.	-0.	-0.	C
282	PBRF 69-01 PIN 013-509B	UN(100)	T-111(24)	2	7100	1307	1255	1.53	0.358	0.	-0.	-0.	-0.	C
283	PBRF 69-01 PIN 020	UN(100)	T-111(63)	2	1990	1290	1255	0.11	0.750	0.201	-0.	-0.	-0.	C
284	PBRF 72-03 PIN 030-505A	UN(100)	T-111(24)	2	1147	1169	1145	0.19	0.358	0.110	-0.	-0.	-0.	C
285	PBRF 72-03 PIN 030-505B	UN(100)	T-111(24)	2	1147	1169	1145	0.19	0.358	0.110	-0.	-0.	-0.	C
286	PBRF 62-12 CAPS. 321A-F	UN-HI(96)	T-111(14)	1	1500	1200	1200	-0.	0.181	0.047	-0.	-0.	-0.	C
287	PBRF 62-12 CAPS. 322A-F	UN-HI(96)	T-111(13)	3	3020	1200	1200	-0.	0.181	0.	-0.	-0.	-0.	C
288	NASA PBR CAPS. 323 PIN A	UN-HI(94)	SS(29)	0	3030	1222	1194	0.98	0.210	0.	1.52	-0.	1.00	C T
289	NASA PBR CAPS. 323 PIN B	UN-HI(94)	SS(29)	1	4121	-0	-0	-0.	0.210	0.	-0.	-0.	-0.	C
290	NASA PBR CAPS. 323 PIN C	UN-HI(94)	SS(29)	1	4121	-0	-0	-0.	0.210	0.	-0.	-0.	-0.	C
291	NASA PBR CAPS. 323 PIN D	UN-HI(94)	SS(29)	1	4121	-0	-0	-0.	0.210	0.	-0.	-0.	-0.	C
292	NASA PBR CAPS. 323 PIN E	UN-HI(94)	SS(29)	1	4121	-0	-0	-0.	0.210	0.	-0.	-0.	-0.	C
293	NASA PBR CAPS. 323 PIN F	UN-HI(94)	SS(29)	1	4121	1284	1256	1.76	0.210	0.	-0.	-0.	-0.	C T
294	NASA PBR CAPS. 325 PIN A	UO2(93)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.070	-0.	-0.	-0.	C E
295	NASA PBR CAPS. 325 PIN B	UN(94)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.070	-0.	-0.	-0.	C E
296	NASA PBR CAPS. 325 PIN C	UO2(93)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.070	-0.	-0.	-0.	C E
297	NASA PBR CAPS. 325 PIN D	UN(94)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.050	-0.	-0.	-0.	C E
298	NASA PBR CAPS. 325 PIN E	UO2(93)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.050	-0.	-0.	-0.	C E
299	NASA PBR CAPS. 325 PIN F	UN(94)	NB-1ZR(16)	1	1817	-0	-0	-0.	0.183	0.050	-0.	-0.	-0.	C E
300	NASA 66-06 PIN 121	UN(93)	TZM(65)	0	1293	-0	-0	8.28	0.180	0.030	-0.	-0.	-0.	PC
301	NASA 66-06 PIN 122	UN(93)	TZM(65)	0	1599	-0	-0	6.59	0.180	0.030	-0.	-0.	-0.	PC
302	NASA 66-06 PIN 123	UN(93)	TZM(65)	0	1893	-0	-0	6.04	0.180	0.030	-0.	-0.	-0.	P
303	NASA 66-06 PIN 124	UN(93)	TZM(65)	0	2418	-0	-0	10.76	0.180	0.030	-0.	-0.	-0.	P
304	NASA 66-06 PIN 125	UN(93)	TZM(65)	0	1938	-0	-0	-0.	0.180	0.030	-0.	-0.	-0.	PC
305	NASA 66-06 PIN 126	UN(93)	TZM(65)	0	1778	-0	-0	-0.	0.180	0.030	-0.	-0.	-0.	PC

NOTES.....

A=POSSIBLE SIGNIFICANT CAN PRESSURE
B=NITROGEN OVERPRESSURE ON FUEL
C=IMPORTANT TEST DATA MISSING
D=TEMPERATURE EXCURSION OCCURRED
E=LINER BETWEEN FUEL AND CLAD
F=EVIDENCE OF VAPOR TRANSPORT
G=THERMOCOUPLE INSIDE FUEL
H=CHEMICAL REACTION FOUND
I=FUEL/CLAD GAP UNKNOWN
J=CLAD IMMERSED IN NAK
K=HYPERSTOICHIOMETRIC
L=HYPOSTOICHIOMETRIC
M=LITHIUM INSIDE PIN
N=ODD CLAD MATERIAL
O=CLAD FAILURE
P=FUEL PIN VENTED
Q=MODELING REF. CASE
R=FMODEL TEST CASE
S=STILL ON TEST
T=CALCULATION MADE

A ZERO MAY ACTUALLY SIGNIFY AN UNKNOWN VALUE

EXPERIMENT FILE NO.259
****

IDENTIFICATION CODE PBRF 69-01 PIN 001-503C // TEST DATES 052570 TO 110171 // REFERENCES -0.

FUEL... UN-MI( ) DENSITY= 94.88 PERCENT, ENRICHMENT= 8.20 PERCENT, GRAIN SIZE= -0. MICRONS, STOICH.=-0. PERCENT

CLAD... T-111(W/ W LINER) DENSITY=100.00 PERCENT

PLUG MATERIAL...

INTERNAL GAS...HELIUM AT 5.14 N/SQCM INIT.(COLD)

INITIAL GEOMETRY		TEST CONDITIONS (AVERAGE/TOTAL)		TEST TEMPERATURES, DEG K	
CLAD OUTER RADIUS (CM) =	0.457840	TEST TIME (HRS) =	8070.	FUEL INNER (MAX) =	-0.
CLAD INNER RADIUS (CM) =	0.397860	NO. OF THERMAL CYCLES=	82.	FUEL INNER (MIN) =	-0.
FUEL OUTER RADIUS (CM) =	0.393960	BURNUP RATE(A/O/HOUR)=	1.11E-04	FUEL INNER (AVG) =	1254.
FUEL INNER RADIUS (CM) =	0.141610	GAMMA HEAT RATE (W/G)=	0.10E+01	FUEL OUTER (MAX) =	-0.
PLUG OUTER RADIUS (CM) =	-0.	FAST FLUX (/SQCM-S) =	0.50E+12	FUEL OUTER (MIN) =	-0.
PLUG INNER RADIUS (CM) =	-0.	THERMAL FLUX(/SQCM-S)=	0.11E+14	FUEL OUTER (AVG) =	-0.
FUEL LENGTH (CM) =	5.712000	MAX/MIN B.U.(RADIAL) =	1.29000	CLAD OUTER (MAX) =	-0.
CLAD LENGTH (CM) =	7.381000	MAX/MIN B.U. (AXIAL) =	1.27000	CLAD OUTER (MIN) =	-0.
VOID VOLUME/FUEL VOLUME=	1.16E-01	EXT.OP.PRESS.(N/SQCM)=	27.50000	CLAD OUTER (AVG) =	1187.
		BURNUP (ATOM PERCENT)=	0.896		
		FISS. HEAT RATE(W/CC)=	338.0		

TEST RESULTS (ALL VALUES IN PERCENT).......

	DRMF/RMF	DRA/RA	DFL/FL	DV/V	DRB/RB	DCL/CL	GAS RELEASE
MAX---	0.5100	0.	1.2800	-0.	-0.3300	-0.	
MIN---	0.1900	0.	-0.5600	-0.	-0.0600	-0.	
AVG---	0.3600	0.	0.5300	1.3000	-0.2500	-0.	0.1000

NOTES.....

PIN CONTAINED 6 FUEL PELLETS OF LENGTH .375-.376 IN. -- NO SPACERS.
TUNGSTEN LINER(LOOSE) IS 3.4 MILS THICK, AND IS INCL. IN CLAD DIMENSION.
TC WELLS EXTEND TO ABOUT THE MIDPOINT OF THE 2ND PELLET FROM EACH END.
AVERAGE INNER FUEL TEMPERATURE WAS 1260 K AT TOP, 1247 K AT BOTTOM.
AVERAGE CLAD TEMPERATURE IS AVG. OF BOL AND EOL CALCULATED VALUES.
MEASURED POST-TEST INTERNAL PRESSURE OF 8.2 N/CM2.
CLAD INTEGRITY OK, 1 PERCENT DUCTILITY AFTER TEST. FUEL IN GOOD CONDITION.
CLAD DELTA OD BASED ON MEASUREMENTS AT 14 LOCATIONS.
ALL PELLET POST-TEST ID'S WITHIN PRE-TEST MEASUREMENT RANGE, EXCEPT
PELLET 4, WHICH WAS 1 MIL GREATER.
MEASURED A POST-TEST VOID VOLUME DECREASE OF .123 CC, WHICH IS 2.9 PERCENT
OF THE ORIGINAL FUEL VOLUME.
BURNUP WAS GREATEST IN THE END PELLETS.
FUEL OD INCREASES WERE .51,.42,.19, 23,.36,.45 PERCENT FOR THE 6 PELLETS.
CLAD OD DECREASE WAS GREATEST IN THE CENTER OF THE PIN.
MEASURED DENSITY DECREASE OF 1.61 PC IN PELLETS 1 AND 6, 1.9 PC IN 3.
RADIAL BURNUP GRADIENT IS FROM TOP OF PELLET 2 -- WAS NOT AS STEEP AT 5.
FUEL LENGTH CHANGES (MAX AND MIN) ARE FOR PELLETS 6 AND 1 RESP.
AVERAGE VOLUME CHANGE IS FROM POST-TEST FUEL DIMENSIONS.
FUEL DID NOT TOUCH CLAD.

(NO INDIVIDUAL CYCLE DATA INCLUDED)

(NO CALCULATION INFORMATION INCLUDED)